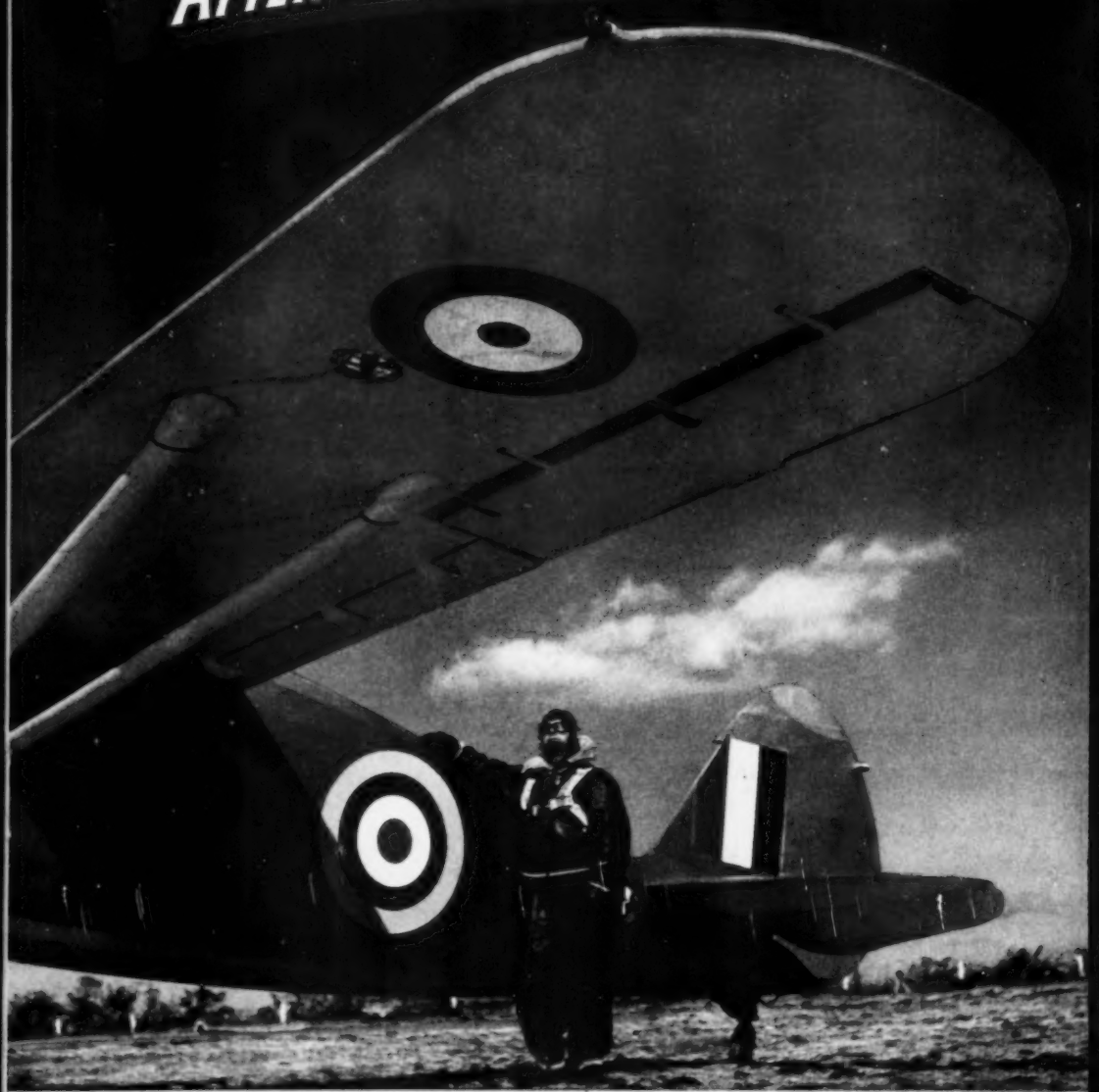
POPULAR SCIENCE

NOV.
20¢
MONTHLY

YOUR CHANCE FOR A BETTER LIFE AFTER THE WAR IS OVER PAGE 66



Split Your Motor, Save 25% In Gas.. PAGE 73

FREE *this valuable* SLIDE RULE

if you accept this amazing offer now!

THIS MAY BE YOUR LAST CHANCE

to get this fine, full-size slide rule free! Many of the materials going into its manufacture are restricted by national defense priorities. When our present supply is gone, this offer may have to be withdrawn—so hurry! Genuine Mannheim type in nicely finished wood with calibrations in contrasting black on white; accurate indicator with reading lens that magnifies. Has A, B, C, D, K, S, T and L scales as on expensive slide rules costing $1.00 or more, and in addition, an inch scale, millimeter scale and table of equivalents. This valuable Slide Rule, with directions for use, is yours free if you accept *promptly* our offer on this marvelous book, "*Speed and Fun with Figures.*"

at last . . . Practical MATHEMATICS made EASY AND ENTERTAINING

Hundreds of Mathematical Short-Cuts—"Lightning Calculators" Secrets Revealed

WHY waste time with roundabout laborious methods of calculation? Why scrawl endless figures on paper to get an answer and then not be sure you are right? Why "hate" mathematics because the old style formal schoolroom way is so slow and dull? Learn the short-cuts! Make mathematics exhilarating, practical, useful in your daily work! Make it the stepping-stone to one of today's many important jobs in mechanical and technical defense industries. Part 1 of this great book cuts the Gordian knot, shows you the proved methods used by lightning calculators to solve difficult problems *instantly*. But that's only the *beginning* of the fascinating and useful information you get from this book.

Marvelous Aid of the Slide Rule Made Clear and Simple

Multiplication and division are no trick at all, complicated roots and powers, trigonometric and reciprocal functions are easy—with this slide rule. The person who can use a slide rule is looked up to by his associates as a "mathematical wizard." But Part 2 of this book shows you how simple it all is.

Mathematics as Recreation—Puzzles, Tricks, Etc.

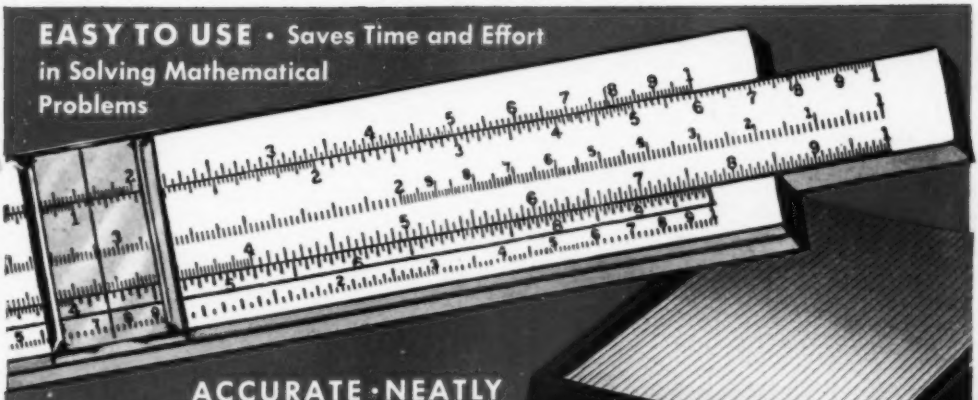
Can you ask a person a few simple, apparently irrelevant questions, and then announce his age? It's a sure-fire popularity winner at any party, along with "The Moon Hoax," the "School Girl Problem," "Cattle Problem of Archimedes," and hundreds of others given in Part 3. All scientifically correct, based on mathematics, affording endless amusement and education, too.

Mathematics Can Help You to Get Ahead—Qualify for the Better Pay Jobs Open Today! Here Are Easy, Time-Saving Methods.

Three complete books by three mathematical authorities have gone into the making of this one fascinating and enlightening volume of 602 pages. No one who uses mathematics in his daily work—or even occasionally—should be without it. "Speed and Fun with Figures" is, we believe, the finest *popular* treatment of Mathematics ever published. It is full of practical rapid methods and short-cuts for the technical worker, student, and teacher. By amusing tricks, puzzles and problems it holds the attention of the layman, too, and helps him to fill in the gaps in his mathematical education. Sent on free approval, with Slide Rule included free!

SAVE OVER 26% BY THIS SPECIAL OFFER! ACT PROMPTLY!

EASY TO USE • Saves Time and Effort in Solving Mathematical Problems



ACCURATE • NEATLY FINISHED • HAS ALL THE SCALES OF A $1.00 RULE

3 GREAT BOOKS

Now in ONE 600-Page Volume!

RAPID ARITHMETIC, by T. O'Connor Sloane, Ph.D., LL.D

Author of "Arithmetic of Electricity," "Standard Electrical Dictionary," "Elementary Electric Calculations," etc.

Notations and signs • Addition • Subtraction • Multiplication • Division • Fractions • The Decimal Point • Interest and Discount • Percentage Calculations • Powers of Numbers • Exponents • Squaring the Circle • Curious Multiplications and Division • Paradoxes and Mysteries • Short Cuts • Etc., etc.

A MANUAL OF THE SLIDE RULE

by J. E. Thompson, B.S. in E.E., A.M.

Department of Mathematics, Pratt Institute, Brooklyn

History and Development of the Slide Rule • Theory and Operation of the Mannheim Slide Rule, including modified forms of this rule, in Multiplication, Division, Reciprocals, Decimals, Combined Multiplication and Division, Proportion, Squares, Cubes and Roots • Typical Problems and Slide Rule Settings • Etc., etc.

RECREATIONS in MATHEMATICS, by H. E. Licks

Arithmetic • Algebra • Geometry • Trigonometry • Analytic Geometry • Calculus • Astronomy and the Calendar • Mechanics and Physics • Amusing Tricks, Puzzles and Mysteries of Mathematics—and hundreds more subjects as fascinating.

EXAMINE IT FREE

"Speed and Fun with Figures" combines three books that sold for $4.75 into one volume for only $3.65. Send no money now. Examine it 5 days FREE. Then return it or send $1.65 as first payment and $1.00 a month for two months until the low price of only $3.65, plus a few cents postage, is paid. Slide Rule included free if you mail the coupon *at once!* D. Van Nostrand Co., Inc., 250 Fourth Ave., New York City.

MAIL THE COUPON TODAY →

SPEED AND FUN WITH FIGURES

SEND NO MONEY—SLIDE RULE FREE

D. Van Nostrand Company, Inc.
250 Fourth Avenue, New York City

Send "Speed and Fun with Figures" on 5 DAYS' FREE APPROVAL, and include the Slide Rule FREE. At the end of 5 days I will return the shipment or send $1.65 as first payment and $1.00 a month for two months, until the low price of only $3.65, plus a few cents postage, is paid. P.S.M. 11-42

Name.....
PLEASE PRINT

Address.....

City.....State.....

Reference.....

Address.....

☐ Check here if you send $3.65 payment in full, in which case WE will pay postage. Same return privilege.

POPULAR SCIENCE

FOUNDED 1872 MONTHLY VOL. 141 NO. 5

Mechanics & Handicraft

A TECHNICAL JOURNAL OF SCIENCE AND INDUSTRY

CONTENTS *for* NOVEMBER, 1942

News

Bubble Glass 49
War Brings Back the Moss Harvest.... 52
Two Guns for One..... 54
Black Light Aids Night Fighters..... 62
War's End Will Bring a Better Life.... 66
Heaviest Ship Is Launched..... 79
Quartz Gives Radio Sharper Ears..... 82
Ciphers: Secret Language of War..... 86
The Jeep Gets a Big Brother..... 90
Protecting Wood from Fire Bombs..... 98
Biggest Army Rifle on Wheels..... 101
Backing Up the Glory Boys..... 106
Building Ships with Packing Cases.... 114
Steel's Tough Partner..... 118
Fireworks in War..... 124

Automobiles

Cutting Your Motor in Half..... 73
Carburetors Need Care..... 138
Gus Wilson's Model Garage..... 145

Home and Workshop

How to Build Home-Movie Sets..... 130
Using a Machinist's Steel Rule.....HW 320
Toy Army Tank Built of Wood.....HW 321
Jigsaw Puzzles Go Military.....HW 326
Curved Work on a Wood Shaper....HW 334
Fighting Rust in the Shop.....HW 360
Repairing Cracks in Masonry.....HW 365
Home Fun with a Microscope.....HW 372
Radio Department .....HW 381

Departments

Our Readers Say:..... 14
Un-Natural History 85
Here's My Story 104

(Contents continued on page 4)

What Do You Know?

Every issue of Popular Science contains hundreds of up-to-the-minute facts and new ideas. How many of the following questions can you answer? Turn to the given references in this issue to verify your answers.

Will glass float? (Caption, page 51.)

A French 75 is worthless for shelling the reverse slope of a high hill. Why? (Illustration, page 54.)

What is a drogue? (Page 81.)

How can a fence, a stack of lumber, or a shelf of books convey a cipher message? (Text, page 87.)

What are high-flotation tires? (Caption, page 94.)

Osnaburg is not a European village, but something our Army finds useful. What is it? (Caption, page 116.)

When steelmakers call iron "red-short," what's wrong with it? (Text, page 119.)

Where do mine shafts come to the surface in the heart of a city's business district? (Text, page 121.)

If troops stealing into open enemy territory by night are suddenly exposed to the light of a flare, how can they best avoid detection? (Text, page 126.)

What is a "wild wall"? (Caption, page 133.)

Is gasoline a good solvent for cleaning dirt deposits from inner carburetor parts? (Text, page 140.)

Why may rust form on iron and steel surfaces under a coating of grease? (Text, page HW 363.)

EDITOR • • • • • • **Charles McLendon**
MANAGING EDITOR • **George H. Waltz, Jr.**
HOME & WORKSHOP EDITOR Arthur Wakeling

ASSOCIATES: Carsten Grande, ***Art Editor;*** **Fred O. Newman,** ***News;*** **William Morris,** ***Photography;*** **Schuyler Van Duyne,** ***Automobiles;*** **Alden P. Armagnac, Harry Walton,** ***Group Editors;*** **B. T. Richards,** ***Copy Editor;*** **Michele de Santis, Harry Samuels, Stewart Rouse, Michael Cerniello,** ***Art Assistants.***

Published monthly at 353 Fourth Avenue, New York, N. Y. by Popular Science Publishing Co., Inc. Godfrey Hammond, President and Treasurer; R. C. Wilson, Raymond J. Brown, Vice Presidents; F. W. Briggs, Secretary. Entered as second-class matter Dec. 28, 1918, at the Post Office at New York under the act of March 3, 1879; additional entry as second-class matter at Dayton, Ohio. Entered as second-class matter at the Post Office Department, Canada. Printed in U.S.A.

Copyright, 1942, by Popular Science Publishing Co., Inc. All rights reserved in the United States, Great Britain, and in all countries participating in the International Copyright Convention and the Pan American Copyright Convention.

Yearly subscriptions to United States and its possessions, $2.00; Canada, $2.50; foreign countries, excepting Canada, $3.00. Subscribers must notify us of change of address four weeks in advance of the next publication date. Be sure to give both old and new address.

Don't think the planes of the future aren't *already here!* They are! But, of course, these giants aren't carrying pleasure cars and vacationists. Troops and jeeps and equipment fill their holds.

Just imagine the Day of Victory has already arrived. Visualize the multi-motor bombers and transports of today as fleets of freight planes and super liners.

As sure as Victory will be ours, the America that lies ahead will be a land that brings the horizon to your back door. It will be a land that leads mankind to a new concept of civilization. Today's production lines are geared to it. Today's Americans are working for it.

When the aviation industry was in knee pants, we of B. F. Goodrich started our aeronautical division. Planes were fragile, slow, unsafe. The pilots who flew them were daredevils. But every day some new miracle of ingenuity took place.

For example, from the B. F. Goodrich research laboratories came a new type of aircraft tire, a low-pressure Silvertown which made aircraft take-offs and landings smoother and safer. This helped pave the way for heavier planes. We developed a new type of brake that greatly increased a pilot's ground-control. This helped pave the way for greater speeds. We developed De-Icers, which protect wings, tail and rudder from ice.

Today, the greatest air force in the world is using this equipment. As the air power of the United Nations grows in strength, the Day of Victory looms nearer. And, when it arrives, we at B. F. Goodrich won't even take time out to look up from our work.

We will start right off on our new job—turning out aircraft equipment for the conquest of new worlds . . . for the creation of a new America. The B. F. Goodrich Co., Aeronautical Division, Akron, Ohio.

BFG

Skyway or Highway

B.F.Goodrich

FIRST IN RUBBER

Contents [CONTINUED]

Automobiles

"Slip Covers" for Tires..... 80
Coupe Makes Emergency Ambulance 142
Hints for Motorists..... 143
Auto Ideas 144

Facts and Ideas

Raincoats Without Rubber..... 59
Portable Airless Blaster..... 60
Long-Nosed Cutter-Retriever 60
Flexible Drill Shaft..... 60
Molded Slugs Make Shotgun Deadly 61
Airport Crash Truck..... 64
Invasion Glider Carries 15 Men.... 80
Plane Has Tail Brake..... 81
Inventors' Ways to Win the War... 112
Kit Identifies Textile Fibers..... 122
Troops May Use Roller Skates..... 123
Sweepings Made to Pay..... 129

Photography

How to Build Home Movie Sets.... 130
Cigar-Box Table Tripod and Case... 134
New Devices for Camera Users..... 135
Feed Pan Serves as Print Washer... 136
Dowels Used to Straighten Prints... 136
Stops Control Spotlight Shadows... 137

Craftwork

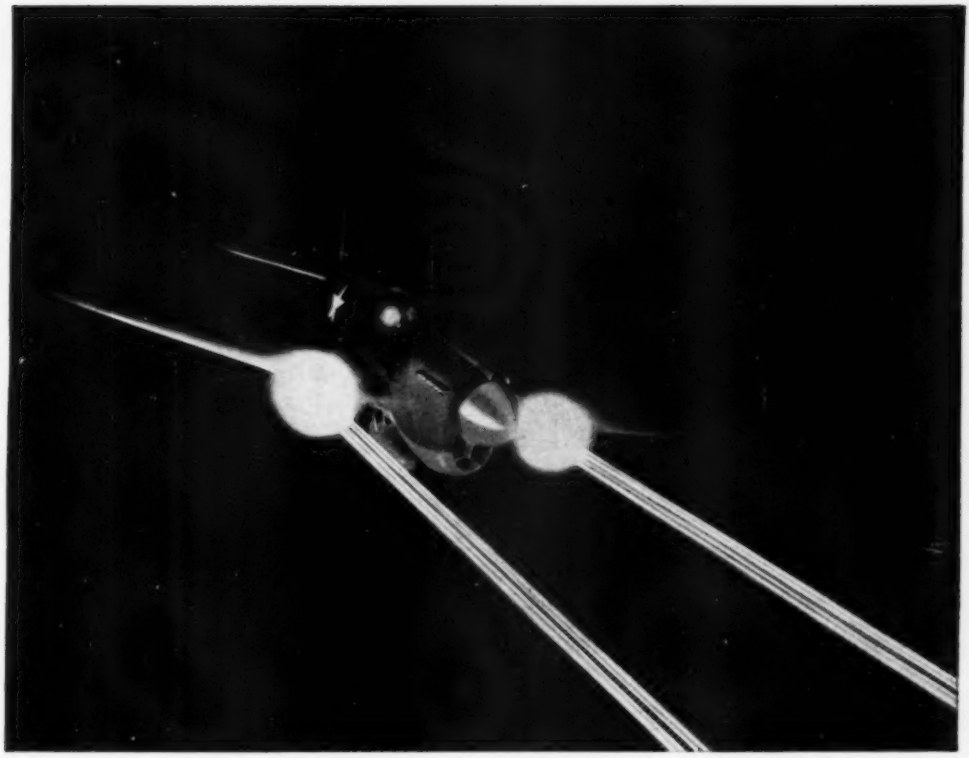
Jigsaw Puzzles Go Military.....HW 326
Nautical Salt and Pepper Set.....HW 340
Revolving Reference Bookcase...HW 352
Winged-Top Cigarette Box.....HW 352
Adjustable Photograph Holder....HW 354
Model-Railway Switchwork .....HW 370

Home Building

Products for Home Owners.....HW 338
New Blackout Accessories.....HW 339
Converting Oil Burner to Coal....HW 348
Helps for the Householder.....HW 358

(Continued on page 6)

IMPORTANT NOTICE: The contents of this magazine must not be reprinted without permission. The editors are not responsible for unsolicited contributions, and cannot guarantee the return of such material or insure against its loss. Contributions not accompanied by sufficient postage will not be returned. In presenting numerous stories of new products of applied science, Popular Science Monthly does not underwrite the business methods of the individuals or concerns producing them. To avoid liability for patent infringement, readers should investigate before making, using, or offering for sale any of the devices, machines, or processes described; Popular Science Monthly takes no responsibility. The use of Popular Science Monthly articles for stock-selling schemes is never authorized.



He's firing telephone wire at a Zero!

THIS fighter plane, with its six wing guns spitting fire, uses up enough copper every minute to make several miles of telephone line.

That's the right use for copper now — and it's the reason why we can't continue to expand our facilities to take care of the expanding Long Distance telephone traffic.

Right now, our lines are flooded with Long Distance calls. Most of them have to do with the war — they must have the right of way.

Will you help us keep the wires clear for war calls — industrial calls that send a plane down the assembly line — military calls that send it into the air against the enemy?

You can do it by keeping your own calls as few and as brief as possible. And you'll be bringing Victory that much nearer.

Bell Telephone System

NOW! You Can Afford $10,000 Life Insurance

THESE LOW RATES MAKE IT POSSIBLE

● Here is a long-term policy that protects you for the expectancy of life based on your age, according to the American Experience Table of Mortality. It has cash and loan values.

Age	Monthly Rate Per $1,000
20	$ .90
25	.98
30	1.12
35	1.28
40	1.54
45	1.89
50	2.43

AT AGE 35 a $10,000 policy costs you only $12.80 per month and will, should you die during the expectancy period, pay your beneficiary $10,000 or a monthly income for life. This low-cost policy cannot be issued in amounts less than $2,500. Write for full details, stating date of birth. Use coupon below.

More Than A Billion Dollars of Insurance In Force

THE LINCOLN NATIONAL LIFE INSURANCE COMPANY

Fort Wayne, Indiana

ITS NAME INDICATES ITS CHARACTER

THE LINCOLN NATIONAL LIFE INSURANCE COMPANY

Dept. PC-11, Fort Wayne, Indiana

Send full details about your Low Cost Plan, which provides ample protection at low cost.

*Name*_____

*Street Address*_____

*City and State*_____

*Date of Birth*_____

Contents (CONTINUED)

Repairing Cracks in Masonry.....HW 365
Coal Booster Saves Fuel Oil.....HW 369

Miscellaneous

Identify Ten Common Chisels....HW 333
Keeping the Home Shipshape....HW 356
Bicycle-Lock Socket on Frame...HW 369
Having Fun with a Microscope...HW 372
How Your Heating Plant Works..HW 376
Chemistry Tests with Sugar.....HW 378

New Shop Ideas

Using a Machinist's Steel Rule...HW 320
Outside-Closing Collet Chucks....HW 332
Micrometer-Head Depth Gauge...HW 332
Cooling Soldering-Iron Handle...HW 341
High-Speed Tailstock Drill.....HW 342
Jig for Bending Sheet Metal.....HW 347
Tool-Bit Grinding Fixture.....HW 355
Lag Screws Keep Bench Level....HW 355
Fighting Rust in the Shop.....HW 360
Guiding Die Near Conduit Bend..HW 364

Shop Data

Electroplating with Zinc.....HW 325
Finishing Leather Articles.....HW 329
Types of Sockets to Use.....HW 341
Cutting Speeds for Drills.....HW 347
Patching Plaster or Filler.....HW 355
Rustproofing Metal Articles.....HW 361
Paint Spots on Clothing.....HW 364

The Handy Man

Accurate Emergency Level.....HW 357
Handy Plywood Clip Board.....HW 357
Hood Welded on Coal Scoop.....HW 357
Driving Screw in Tight Corner...HW 357
Cap Helps in Driving Stakes.....HW 357
Wire-Cloth Box Holds Leaves...HW 357

Woodworking

Toy Army Tank Built of Wood...HW 321
Buffet Chest for Table Silver....HW 330
Curved Work on a Wood Shaper..HW 334
Shaping Cuts on Candlestick.....HW 337
Tool Bores Smooth-Bottom Hole..HW 347
Collapsible Bed Tray and Cot....HW 350
Blade Retainer on Coping Saw....HW 364
Improved Saw-Chuck Setscrew...HW 364

A million tons of rubber

....GOING TO WASTE!

YOU'D demand *action*—if you knew that a million tons of rubber were going to waste, when it's vital to our war effort.

And yet the fact is, a million *men* are "going to waste" in low-paid, unskilled jobs—when, with a few months of practical, spare-time *training*, they might be doing more important, better paid work in some victory-vital shop or factory!

And America needs *trained man-power* as much as she needs rubber and gasoline!

You can demand *action* on this matter, too—by mailing this coupon today, and learning how quickly a low-cost I. C. S. Course can fit you to be a better fighter on the business and industrial front!

Act right now—the world won't wait for slow-pokes!

INTERNATIONAL CORRESPONDENCE SCHOOLS

HELPING TO TRAIN AMERICANS FOR VICTORY

BOX 7640-K, SCRANTON, PENNA.

Without cost or obligation, please send me a copy of your booklet, "Who Wins and Why," and full particulars about the course *before* which I have marked X:

TECHNICAL AND INDUSTRIAL COURSES

☐ Air Brake
☐ Air Conditioning
☐ Airplane Drafting
☐ Architectural Drafting
☐ Architecture
☐ Auto Engine Tune-up
☐ Auto Technician
☐ Aviation ☐ Aviation Mechanic
☐ Blueprint Reading
☐ Boilermaking
☐ Bridge Engineering
☐ Chemistry ☐ Coal Mining
☐ Civil Engineering
☐ Concrete Engineering
☐ Contracting and Building
☐ Cotton Manufacturing
☐ Diesel Engines
☐ Electrical Drafting
☐ Electrical Engineering
☐ Electrician
☐ Electric Lighting
☐ Foundryman ☐ Heating
☐ Heat Treatment of Metals
☐ Highway Engineering
☐ House Planning
☐ Industrial Metallurgy
☐ Locomotive Engineer
☐ Machinist ☐ Inspector
☐ Management of Inventions
☐ Marine Engines
☐ Mechanical Drafting
☐ Mechanical Engineering
☐ Mine Foreman
☐ Navigation ☐ Patternmaking
☐ Plastics ☐ Plumbing
☐ Public Works Engineering
☐ Pulp and Paper Making
☐ Radio, General
☐ Radio Operating
☐ Radio Servicing
☐ R. R. Section Foreman
☐ R. R. Signalman ☐ Refrigeration
☐ Sanitary Engineering
☐ Sheet Metal Work
☐ Ship Drafting
☐ Shipfitting ☐ Shop Practice
☐ Steam Electric ☐ Steam Engines
☐ Steam Fitting
☐ Structural Drafting
☐ Structural Engineering
☐ Surveying and Mapping
☐ Telegraphy ☐ Telephony
☐ Textile Designing
☐ Toolmaking ☐ Tool Design
☐ Welding, Gas and Electric
☐ Woolen Manufacturing

BUSINESS COURSES

☐ Accounting ☐ Advertising
☐ Bookkeeping
☐ Business Correspondence
☐ Business Management
☐ Cartooning ☐ Civil Service
☐ College Preparatory
☐ Commercial
☐ Commercial Illustrating
☐ Cost Accounting
☐ C. P. Accounting
☐ First Year College
☐ Foremanship ☐ French
☐ Good English
☐ High School
☐ Managing Men at Work
☐ Railway Postal Clerk
☐ Salesmanship
☐ Secretarial ☐ Spanish
☐ Showcard and Sign Lettering
☐ Traffic Management

HOME ECONOMICS COURSES

☐ Advanced Dressmaking
☐ Foods and Cookery
☐ Home Dressmaking
☐ Professional Dressmaking and Designing
☐ Tea Room and Cafeteria Management, Catering

Name.....*Age*.....*Address*.....

City.....*State*.....*Present Position*.....

Canadian residents send coupon to International Correspondence Schools Canadian, Limited, Montreal, Canada
British residents send coupon to I. C. S., 71 Kingsway, London, W. C. 2, England

ELECTRIC

AT LAST! Here is a set of Electrical Books understandable language for the "beginner" or

AMAZING 3 VOLUME Electrical Reference Set

AUTHORITATIVE. PRACTICAL—prepared by experts. Used regularly **on the job** by hundreds of Electricians, service men, radio men, air cadets, students, maintenance men, etc. **EASY. COMPLETE.** Covers **everything Electrical:** Armature winding, A.C. and D.C. Motors, generators, electronics, automotive electricity, refrigeration, etc., etc. Answers your electrical questions quickly, clearly, completely.

RADIO AND TELEVISION INCLUDED

In addition to all branches of Electricity, this remarkable set also covers Radio and Television. Tells how to build, troubleshoot, make repairs. Over 100 pictures and 240 diagrams in this section alone!

Remember—this is not a correspondence course. No lessons or tests to be sent in. You study at home when you have the time or use it as a ready reference. These fine big books are always ready whenever you want to look up any electrical or radio problem, and **every subject is clearly indexed so it's easy to locate any subject.**

SEND NO MONEY! COUPON BRINGS COMPLETE SET

Mail the special no-risk coupon on the opposite page. I'll send you ALL THREE of these big, handsomely bound, lavishly illustrated volumes for you to examine in your own home, on my free 7-day trial. It won't cost you a penny unless you decide to keep the set.

Surely no offer could be fairer. Certainly nothing could more clearly show my confidence in this amazing set of Electrical and Radio Reference Books. Why, I even PAY THE POSTAGE. Don't miss this sensational opportunity!

FREE WITH REFERENCE BOOKS

Ask to see these books now, and I'll include Certificate entitling you to 1 full year of Personal, Technical Service by mail after you purchase them. This means you can write to me and receive special information from my staff of consultants on any radio or electrical subject.

43 Years' Experience In Practical Shop Methods is Packed into this 3-Volume Set

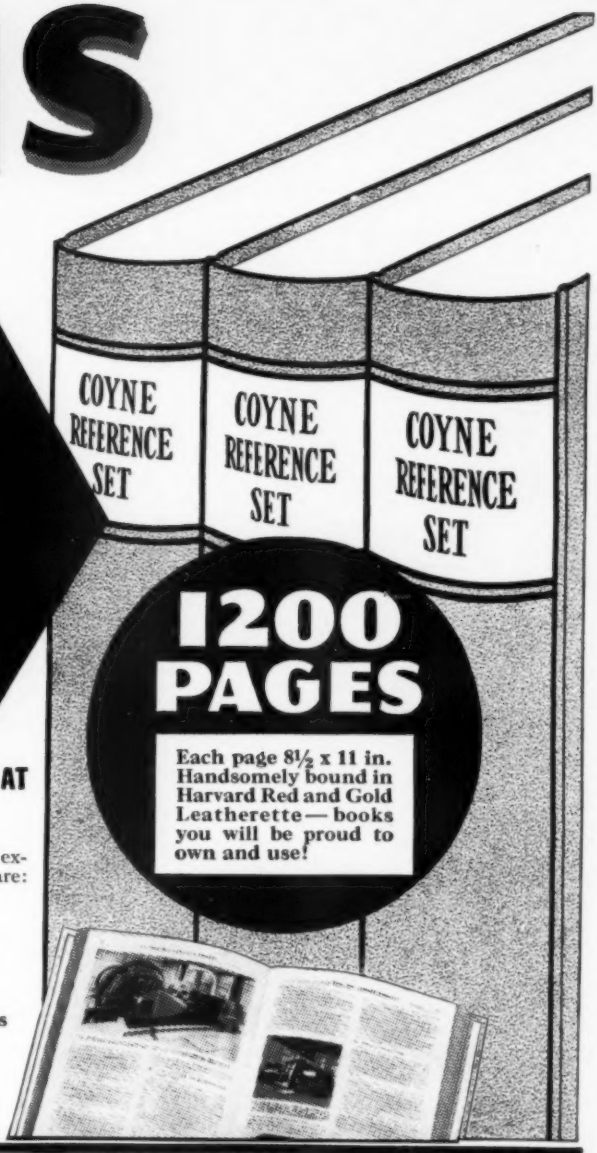
The material in these books duplicates as nearly as is possible in book form, the practical "Learn-by-Doing" training given in the famous Coyne shops.

H. C. LEWIS
500 SO. PAULINA STREET
Dept. 82-R2 Chicago, Ill.

IANS

written in simple, the "old timer."

FREE 7 DAY TRIAL


COYNE REFERENCE SET
COYNE REFERENCE SET
COYNE REFERENCE SET
1200 PAGES
Each page 8½ x 11 in. Handsomely bound in Harvard Red and Gold Leatherette — books you will be proud to own and use!

2000 PICTURES AND DIAGRAMS!

2000 ELECTRICAL SUBJECTS* AT YOUR FINGER TIPS!

A few of the many branches of Electricity explained and pictured in this amazing set are:

Air Conditioning	**Electric Signs**
Telephony	**Home Appliances**
Auto Electricity	**Switchboards**
Talking Pictures	**Power Plants**
Generators	**Diesel Engines**
Refrigeration	**Motors—Armatures**
House Wiring	**A.C. and D.C.**

*Complete Ready Reference Index of over 2000 listings tells you instantly where to look up any electrical fact.

SEE THEM—RISK FREE!

Don't send a penny. Simply mail coupon below and receive your set. Examine books 7 days, with no obligation. Then, if you decide they are the finest, most practical reference set you ever saw, send $3, and the same amount monthly until total price of $12 is paid. I'll prepay all shipping charges. Offer is limited.

MAIL COUPON NOW!

H. C. LEWIS,
500 S. Paulina St., Dept. 82-R2, Chicago, Ill.

Send me the big 3-volume Coyne Electrical Reference and Instruction Encyclopedia, **postpaid.** Within 7 days after receiving the books, I'll either return them or send you $3, and $3 a month until advertised price of $12 is paid.

NAME.....

ADDRESS.....

CITY.....STATE.....

OCCUPATION.....AGE.....

SAVE 10%. **Send cash price, $10.80, with order if preferred—you save $1.20. Same 7-day free trial and return privilege.**

Be a Radio

MANY MAKE $30,

J. E. SMITH
President
National Radio
Institute
Est. 27 Years

I Train BEGINNERS at Home for Good Spare Time and Full Time Radio Jobs

Here's your opportunity to get a good job in a field with a big peacetime future! There is a shortage today of trained Radio Technicians and Operators. If you're in a rut, worried because your present job has no future—find out about RADIO!

Mail the Coupon. I will send you FREE my 64-page, illustrated Book, RICH REWARDS IN RADIO. It describes many fascinating types of Radio jobs; tells how N. R. I. trains you at home in spare time; how you learn by building fascinating Radio Circuits with SIX BIG KITS OF RADIO PARTS I send!

ACT NOW! Many Beginners Quickly Make $5, $10 Extra a Week

Many N. R. I. Students make $5, $10 EXTRA MONEY in spare time while learning. I send EXTRA MONEY JOB SHEETS that tell how to do it!

Right now, probably in your neighborhood, there's room for a spare and full time Radio Technician. Many spare time Technicians are starting their own FULL time shops . . . making $30, $40, $50 a week!

Others take good-pay jobs with Radio Broadcasting Stations. Many more are needed for Government jobs as Civilian Operators, Technicians. Radio Manufacturers employ trained Technicians to help fill Government wartime orders. Aviation, Commercial, Police Radio and Loudspeaker Systems continue to be live, growing fields. And think of the NEW jobs Television, Frequency Modulation, and other Radio developments will open up after the war! I give you the Radio knowledge required for jobs in these fields.

Men I Train Win Success Like This

$10 a Week in Spare Time

"I repaired some Radio sets when I was on my tenth lesson. I really don't see how you can give so much for such a small amount of money. I made $600 in a year and a half, and I have made an average of $10 a week—just spare time." JOHN JERRY, 1126 Mariposa St., Denver, Colorado.

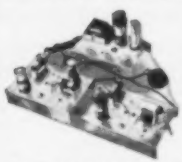
Salary Increased $1,800 Year in Radio

"I have been regularly employed in Radio since my graduation. I have been Chief Engineer of three broadcast stations, and at present time am Chief Engineer of WDOD. My salary has increased $1,800 per year since entering Radio and credit is given you for your excellent training." JULIUS C. VESSELS, Station WDOD, Chattanooga, Tenn.

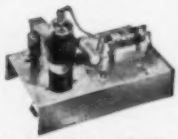
$200 a Month in Own Business

"For several years I have been in business for myself making around $200 a month. Business has steadily increased. I have N. R. I. to thank for my start in this field." ARLIE J. FROEHNER, 300 W. Texas Ave., Goose Creek, Texas.

Build These Radio Circuits With Parts I Send!



MEASURING INSTRUMENT. Built early in Course. Use it to locate defects, service Radios in your neighborhood, earn EXTRA MONEY while you learn!



A. M. SIGNAL GENERATOR. Build it yourself. It provides amplitude-modulated signal for testing and experimental purposes. I send all parts, instructions, for building **these and other Radio Units!**

SUPERHETERODYNE CIRCUIT. Receives Local and Distant Stations. Build it with parts I supply. Use it to make fascinating tests, experiments, **prove** what you learn from my illustrated lessons!

By the time you've conducted 60 sets of Experiments with Radio Parts I supply—have made hundreds of measurements and adjustments—you'll have valuable PRACTICAL experience.

FIND OUT ABOUT THIS TESTED WAY

Technician

$40, $50 A WEEK

How My "50-50 Method" Paves the Way to Bigger Pay

My "50-50 Method"—half building and testing Radio Circuits, half learning from illustrated lessons—is a tested, proved method. Think how much you'll **learn** by building the "Superhet" and Measuring Instrument illustrated below—by conducting 60 sets of experiments on these and other circuits you build with parts I supply! Before you know it you are "old friends" with the miracle of Radio. You run your own Spare Time Shop, fix the Radios of your friends and neighbors—get **paid** while learning!

Extra Pay in Army, Navy, Too

Men likely to go into military service, soldiers, sailors, marines, should mail the Coupon Now! Learning Radio helps men get extra rank, extra prestige, more interesting duties, MUCH HIGHER PAY. Hundreds now in service are N. R. I. students. Also prepares for good Radio jobs, after service ends.

A Great School Helps You Toward the Rich Rewards of Radio

In 27 years since N. R. I. pioneered the home study of Radio, I've seen my method help thousands jump their pay. It's not a "miracle cure" nor a "long chance" operation. It is a time-tested, practical way to prepare for a full time Radio job paying up to $50 a week. Instead of struggling along by yourself, you "team up" with an organization that **knows how** to help beginners get started.

Find Out What N. R. I. Can Do For YOU

MAIL THE COUPON for my FREE 64-page book. It is packed with Radio facts, things you never knew about opportunities in Broadcasting, Radio Servicing, Manufacturing, other Radio fields.

You'll read a complete description of my Course—"50-50 Method"—6 Experimental Kits—Extra Money Job Sheets. You'll see the fascinating jobs Radio offers and how **YOU** can train at home. No obligation. If you want to JUMP YOUR PAY—Mail Coupon AT ONCE! **J. E. Smith, President, Dept. 2MP3, National Radio Institute, Washington, D.C.**

Broadcasting Stations employ N. R. I. trained Radio Technicians as operators, installation, maintenance men and in other capacities and pay well.

THIS Free Book HAS HELPED HUNDREDS OF MEN MAKE MORE MONEY

Training Men For Vital Radio Jobs

Set Servicing pays many N. R. I. trained Radio Technicians $30, $40, $50 a week. Others hold their regular jobs and make $5 to $10 extra a week in spare time.

TO BETTER PAY

Mail this to get 64 page book FREE

J. E. SMITH, President, Dept. 2MP3
National Radio Institute, Washington, D. C.

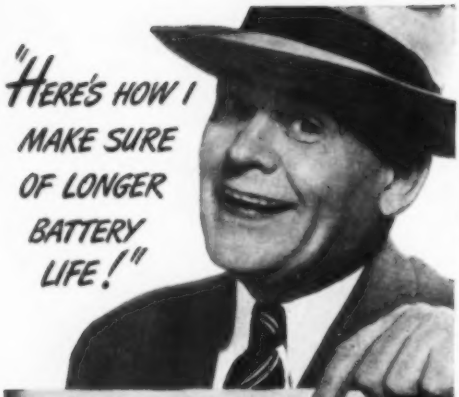
Dear Mr. Smith: Mail me FREE, without obligation, your 64-page book, "Rich Rewards in Radio," which points out Radio's opportunities and tells how you train men at home to be Radio Technicians. (No salesman will call. Please write or print plainly.)

Age.....

Name.....

Address.....

City.....State.....



DOUBLE CHECK shows Experts Specify Auto-Lite Batteries

FOR years engineering experts have specified Auto-Lite Batteries as original equipment for 1 out of every 3 makes of cars. They pick them for giant ocean-spanning clippers too, where dependability counts most. For longer life, extra power, ask for Auto-Lite Batteries . . . now priced with the lowest.

USL BATTERY CORPORATION
Niagara Falls · (A Subsidiary of The Electric Auto-Lite Company) · New York

Double Check for Extra Battery Life

✓ Every 1,000 miles use this 4-way service—test charge, add water, remove corrosion, tighten battery in place.

✓ Auto-Lite Battery service men can advise you on the size and type of battery for best service, longest life.

AUTO-LITE MEANS AUTO LIFE

IN ITS 26 GREAT MANUFACTURING DIVISIONS, AUTO-LITE IS PRODUCING FOR AMERICA'S ARMED FORCES ON LAND, SEA AND IN THE AIR

Coming Next Month—

UNCLE SAM'S TRUMP CARD in the game of aerial warfare may well turn out to be the P-47 Thunderbolt, described by experts as the fastest, highest-flying fighter plane in the world. An article tells all that can be told about a ship which will take on anything Hitler and Hirohito can send against it.

NECESSITY, we all know, is the mother of invention, and the spur of wartime demands is forcing improvements that will carry over into everyday life in peacetime. In many fields, "substitute" materials are proving better and cheaper than the time-honored materials they replace. Read the story of how it took a war to teach us better ways of doing things.

CHRISTMAS IS COMING around this year on the usual day, war or no war. For home-workshop fans who like to make their own gifts, we offer plans for making a wide variety of toys and furniture for children; a simplified model of one of the latest U. S. cruisers; an improved Priscilla sewing cabinet for the Missus; and several pieces of attractive craftwork.

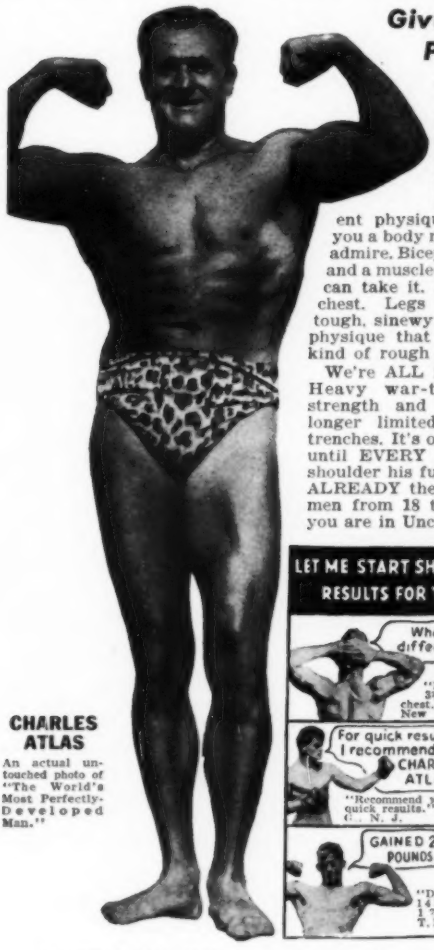
GOT YOUR GAS MASK? If not, you can make a reasonably effective one from a rubber bathing cap, a tin can, a fly swatter, and a few other equally unlikely odds and ends. Pictures and text show you just how to do it. This is not intended to take the place of an approved mask, but it's a lot better than wet towels, blankets, and other makeshifts.

AN ELECTRIC CANNON that shoots six-inch shells 90 miles at the rate of 750 a minute—that's the newest German weapon, but fortunately it exists only on paper and is likely to remain there for quite a while. You'll want to read about it and see the drawings in which our artist interprets this Nazi blueprint for destruction.

FLUORESCENT LAMPS are being more and more widely used, and it's high time that the handy man learned how to keep them working properly. An article by Harold P. Strand tells you what you need to know about the way fluorescent lamps work, how to find out what's wrong with a balky one, and how to remedy the trouble.

Confidentially... I LIKE HE-MEN!

. . . and what girl *doesn't* thrill at the sight of a powerful, big-muscled MAN! What girl would prefer to date a flabby-armed, flat-chested WEAKLING—if she *could* date a husky, broad-shouldered HE-MAN! If YOU are not satisfied with your build, read CHARLES ATLAS' amazing offer here:

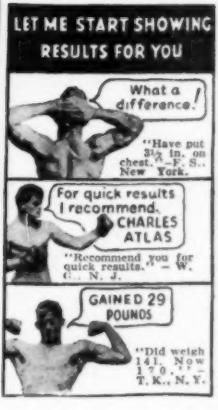


CHARLES ATLAS
An actual untouched photo of "The World's Most Perfectly-Developed Man."

Give Me Just 15 Minutes a Day and I'll Prove I Can Make You A NEW MAN!

THAT'S what I said—*15 minutes a day!* That's all I need to PROVE—regardless of how old or young you are, or how ashamed you may be of your present physique—that I can give you a body men envy and women admire. Biceps that can dish it out, and a muscle-ridged stomach that can take it. A full, deep barrel-chest. Legs that never tire. A tough, sinewy back. An all-around physique that can laugh at ANY kind of rough going.

We're ALL in the Army today! Heavy war-time demands on strength and endurance are no longer limited to the front-line trenches. It's only a matter of time until EVERY citizen is called to shoulder his full share of the load. ALREADY the Army has enrolled men from 18 to 64. And whether you are in Uncle Sam's Services or a home-front civilian, you've GOT to be in 100% SHAPE. Every man, young or old, owes it to himself to get a body with the bulldog staying power that double shifts of working call for. HOW DO *YOU* STACK UP?


LET ME START SHOWING RESULTS FOR YOU
What a difference!
"Have put 3½ in. on chest." — F. S., New York.
For quick results I recommend CHARLES ATLAS
"Recommend you for quick results." — W. G., N. J.
GAINED 29 POUNDS
"Did weigh 141. Now 170." — T. K., N. Y.

Would You Believe I Was Once a 97-lb. Weakling?

Yes, I *was*—a miserable 97-pound bag of skin and bones. But you'd never believe it to look at me now, would you? Through my discovery of *"Dynamic Tension"* I changed myself into "The World's Most Perfectly-Developed Man." I'm LIVING PROOF of the miracles *"Dynamic Tension"* can perform—right in the privacy of your own home! NOW—will you give my method 15 minutes a day to get the kind of HE-MAN build you have always longed to have?

FREE BOOK "Everlasting Health and Strength"

Just a stamp will bring my famous book, "Everlasting Health and Strength," FREE. Nearly 2,000,000 men have sent for this 48-page story—illustrated with action photos of myself and my pupils. You'll read about my secret of *"Dynamic Tension"*—and SEE PROOF of it!

CHARLES ATLAS, Dept. 1-ZB, 115 East 23rd Street, New York, N. Y.

CHARLES ATLAS, Dept. 1-ZB,
115 East 23rd Street, New York, N. Y.

I want the proof that your system of "Dynamic Tension" will help make a New Man of me—give me a healthy, husky body and big muscular development. Send me your free book, **"Everlasting Health and Strength."**

Name _____
(Please print or write plainly)

Address _____

City _____ State _____

Readers Say:

Christmas Presents for Navy Men Must Be Mailed by November 1

IT WOULD BE a real service to men in the Navy if you would publish the following message from the Bureau of Personnel:

"November 1st is the deadline for mailing Christmas packages to men in the Navy on foreign station or on shipboard if you want to be sure they will reach the men by Christmas Day, warns the Navy Department. Packages for overseas parcel post must not exceed 11 pounds in weight and must be no more than 18 inches in length and 42 inches combined length and girth. Lightweight packages the size of an ordinary shoe box are preferred. Address must be complete, giving the man's ship or shore station. Return address also must be given. Cost of postage is the parcel post rate to New York or San Francisco; no additional charge for foreign delivery. All mail is subject to censorship. Gifts most acceptable to Navy men are: Toilet kit, wrist watch, notebook, pipe, wallet, pen or pencil, photograph (preferably small and framed), magazine subscriptions or books, small games such as dominoes, sewing kit, things easily transportable and usable in any climate. Articles NOT recommended are: electrical equipment of any kind, food of any sort, clothing unless specifically requested, cameras."—R. W. S., Jr., Washington, D. C.

Yes, We Used to Publish Fiction, But Fact Is Stranger These Days

ABOUT six or eight years ago you sent information on steam automobiles to a gentleman in Macon, Ga., I gather from Our Readers Say of February 1939. Would you please send me the same information? I want to repair an old White, and I know little about steamers. Recently I looked through my old copies of P.S.M., dating back to 1923. Although your magazine was a good one then, it is better now. I couldn't help noticing that Gus and Joe were in the Model Garage 17 years ago. Those cover pictures by Paus were good ones. I reread the novel "Whirling Wheels," which was printed in your magazine. It was a good story, but I think P.S.M. is better without fiction. POPULAR SCIENCE MONTHLY has come a long way in the last 20 years.—G. M., Traer, Iowa.

Homemade Motor Scooter Scoots 65 Miles on a Gallon of Gas

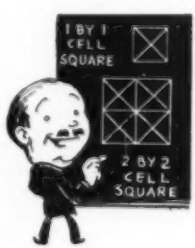
YOU recently helped me out on building a motor scooter. The job is finished now. My scooter has reached a speed of 60 m.p.h. and has a three-speed transmission. I get about 65 miles to the gallon. You may not believe this, but it's exactly the truth. It has most of the features of a motorcycle, and rides very comfortably with suspension springs on the front and with the rear axle mounted on springs. Two people can ride very conveniently.—B. P., Apollo, Pa.

If You Don't Believe It, Count 'em Yourself

IN THE August issue of POPULAR SCIENCE, P.M.C. must have used considerable imagination to find 500,000 triangles in an 8-by-8-cell square, in which each cell is crossed by two diagonals. This figure contains 1,832 triangles. Using this same construction the number of triangles in various sized squares is as follows:

1-by-1	cell	square	contains	8	triangles
2-by-2	"	"	"	44	"
3-by-3	"	"	"	124	"
4-by-4	"	"	"	268	"
5-by-5	"	"	"	492	"
6-by-6	"	"	"	816	"
7-by-7	"	"	"	1,256	"
8-by-8	"	"	"	1,832	"

A rectangle of 4 by 8 cells of the same construction, which has half the area of an 8-by-8-cell square, contains only 654 triangles. There seems to be no square figure of this type that contains an even 500,000 triangles. A 54-by-54-cell square contains 485,568 triangles and a 55-by-55-cell square contains 512,792 triangles. Although the number of triangles may be obtained by a systematic count, it is more convenient to determine these numbers by other methods, one of which is by the use of an easy algebraic formula.



AUDELS HANDY BOOK PRACTICAL ELECTRICITY

• FOR MAINTENANCE ENGINEERS, ELECTRICIANS AND ALL ELECTRICAL WORKERS. PRICE $4. •

HERE IS ELECTRICAL INFORMATION IN A HANDY FORM

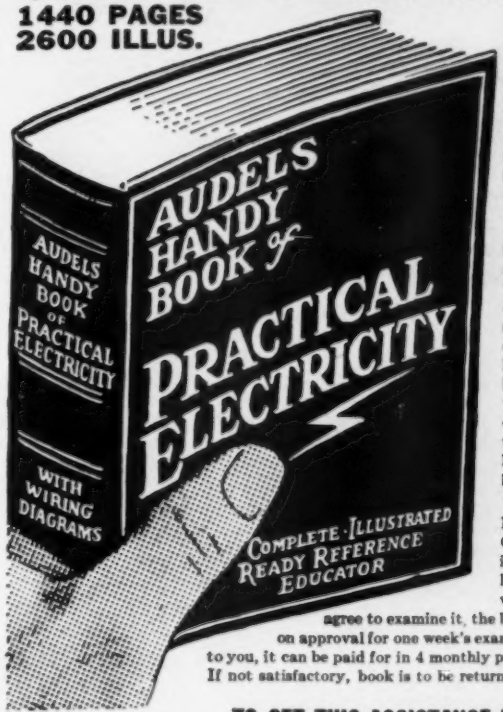
COVERING:

ELECTRICAL ENERGY
MECHANICAL ENERGY
Current Effects—Magnetism
MAGNETIC INDUCTION
D. C. Motors—Dynamos
A. C. Motors—Alternators
ALTERNATOR CONSTRUCTION
Armature Winding
Armature Repairing
WIRING DIAGRAMS
Reverse Current Relays
Overload Relays
Differential Power Relays
Undervoltage Relays
Temperature Relays
ELECTRIC POWER TRANSMISSION
Underground Wiring
Cable Splicing
Switches—Electric Bells
TRANSFORMERS
HOUSE WIRING
Diagram of Connections
Rectifiers—Converters
Power Factors
WATT-HOUR METERS AND CONNECTIONS
Watt-Hour Rules
Meters and Instruments
Circuit Breakers—Fuses
Rheostats and Starting Devices
STORAGE BATTERIES
Electrolysis—Insulators
Electric Lighting
FLUORESCENT
Sign Flashers
NEON SIGNS
Electro Plating
RADIO PRINCIPLES
RADIO QUESTIONS AND ANSWERS
Radio Tubes—Photo Electric Cells
Electric Cranes
POWER WIRING
Substations—Power Station Plans
Plant Management
AUTOMATIC TELEPHONE
Automatic Telephone Switchboards
The Telegraph, Relay System and Codes
ELEVATORS AND CONTROLLERS
Elevator Wiring and Operating Instructions
MARINE WIRING
Electric Ship Drive
ELECTRIC RAILWAYS
Electric Heating
AIR CONDITIONING
Motion Pictures
Domestic Refrigeration
Air Compressors
OIL BURNERS
Pumps—Wiring Calculations
Soldering—Brazing
WELDING
Electro-Therapeutics—X-Rays
Automobile Starting
Automobile Lighting Systems
Ignition
Electrically Operated Tools
Ready Reference Index

YOUR OPPORTUNITY!

"AUDELS HANDY BOOK OF PRACTICAL ELECTRICITY," endorsed by hundreds of experienced workers, you too can profit by the personal ownership of this good book, containing the practical information that every electrical man can use. Clear—concise—explaining the essential facts, figures and rules used in good general practice—and fully illustrated.

1440 PAGES
2600 ILLUS.


AUDELS HANDY BOOK OF PRACTICAL ELECTRICITY
WITH WIRING DIAGRAMS
AUDELS HANDY BOOK of PRACTICAL ELECTRICITY
COMPLETE · ILLUSTRATED READY REFERENCE EDUCATOR

A Practical, Quick, Ready Reference. Gives complete instruction and inside information on electrical subjects. Every point clearly explained in plain language and with diagrams. Subjects arranged progressively for the student, and complete index makes information instantly available to professional workers for ready reference. A time and money saver. A competent and dependable guide and helping hand. Sooner or later this handy book will answer important questions and help you to handle efficiently all kinds of electrical problems.

"AUDELS HANDY BOOK OF PRACTICAL ELECTRICITY" is bringing a helping hand to hundreds of workers and if you will agree to examine it, the book will be sent to you on approval for one week's examination. If found O.K. to you, it can be paid for in 4 monthly payments of $1.00 each. If not satisfactory, book is to be returned in one week.

$4 COMPLETE
PAY ONLY $1 A MO.

TO GET THIS ASSISTANCE FOR YOURSELF SIMPLY FILL IN AND MAIL COUPON TODAY

THEO. AUDEL & CO., 49 W. 23rd St., N. Y.

- - ASK TO SEE IT! - - -

THEO. AUDEL & CO., 49 West 23rd St., New York
Mail AUDELS HANDY BOOK OF PRACTICAL ELECTRICITY (Price $4) on 7 Days' Free Trial. If O.K. I will remit $1 in 7 days and $1 monthly until $4 is paid. Otherwise I will return it.

Name_____

Address_____

Occupation_____

Reference_____ PSM

"That old greenhead never guessed he'd be helping the U. S. Army some day!"

"YOU KNOW, my first day of anti-aircraft firing practice reminded me a lot of my first duck hunt. I was just a kid then, so I was pretty excited when Dad let me go with him. We got out to the blind just before dawn. It was windy and overcast, with a bite in the air. Mallards were flying high overhead, in close formation.

"First thing I know, a big greenhead hovers over the decoys, swings around into the wind, and comes in with a rush. I'm so excited I let him have it about forty yards away. He crumples up and plumps in the drink. It seemed so easy—I figured I'd have my limit in no time at all.

"I kept poppin' away, without so much as gettin' another feather. Long about 10 o'clock, Dad got his fifth clean hit, and said, sorta quiet-like, 'Son, don't shoot where they *are*, shoot where they're *goin'* to be.' . . . Well, that holds good for the 'game' we're tryin' to bring down right now, just as it did for ducks."

Hunting has helped train soldiers for their specialized tasks; it has given America a reserve force of ten million shooters who know the fundamentals of gun-handling. For the fifth time in its history, Remington has turned from its peacetime pursuits to help supply the country's needs.

Here's one way you can help: Take good care of your guns and ammunition. Keep your guns clean; wipe them occasionally with an oily rag to prevent rusting. Remove unused shells from the pockets of a wet hunting coat and from your car. Store ammunition in a cool, dry place. Remember, ammunition properly stored stays good for years. Remington Arms Co., Inc., Bridgeport, Conn.

Remington

DU PONT

Readers Say:

He Has Gas (Charcoal) to Burn in His Automobile

LET'S have a good, long article about converting automobile or other gasoline engines for burning charcoal gas, as used in Europe. I think one of your readers has already suggested this, and believe others will surely be much interested even though it may not be necessary in this country. Keep the articles on chemistry coming. Your magazine is getting better and better.—F. A. M., Rockbridge, Ill.

Try It Out on the Japs—a Shot at a Time

HERE is a problem for your brain-trusting department. Maybe we should worry the Japs with this one. An army decided to pack its shot in boxes measuring 10 by 10 by 5 inches inside. In the case of one-inch balls, how many can be placed in a box? Unless the paper shortage interferes, I would like to see you publish the analysis.—R. D. H., Columbus, Ind.

More About Stroboscopic Effects in Fans, Gears, Saws, and Drills

IN RECENT Readers Say columns there have been several references to different stroboscopic effects. I have seen an effect similar to that of the drill press, as an electric fan slowed down to a stop under AC light. R. H.'s assumption about the saw seen under natural light seems to be correct. I tried the same thing with some small gears. As each tooth hits, it momentarily stops. The next tooth jumps into place so quickly that the change is not seen. Many motion-picture projectors use the same principle. One frame of film is shown, and then the next one brought into place so quickly that the change is not seen. More expensive projectors use a shutter to cover up the change in order to prevent streaks and flicker, and get clearer pictures. I think P.S.M. is a swell magazine. It certainly is my favorite. How about some model-airplane plans, or plans for a towline glider? —J. T., Vancouver, Wash.

FREE WITH THIS OFFER

33 POWER TELESCOPE LENS KIT

You can now own a genuine high powered telescope by making it in one evening of easy work. It is included **FREE** with this Special Offer of "Wonders of Science, Simplified." All the optical parts are completely finished for a refracting, astronomical telescope over 4 feet long. You can see the mountains and craters on the moon, the ringed planet Saturn, Jupiter and double stars, etc. See airplanes, ships and hundreds of other interesting sights. Makes objects miles away appear close. Complete lens kit contains 2" diameter ground and polished objective lens and 33 power eyepiece lens made in the good old U.S.A. with full directions for mounting. Read how you can get your 33 power telescope lens kit **FREE** with this offer.

HUNDREDS OF PHOTOGRAPHS, MAPS, DRAWINGS, ETC.

3 Volumes Bound in 1

***Volume I* — PARTIAL CONTENTS**
WONDERS OF NATURE

BOOK 1. History & Mystery of Astronomy
How Men Used to Think of Earth and Sky
How the Solar System Originated
Enormous Size of Some Stars, etc.

BOOK 2. Oddest Phenomena on Earth
Spouting Fountains of Boiling Water
A Marvelous Mountain of Solid Salt

BOOK 3. Watching the World Change
How Continents and Oceans Were Formed
How We Know Ground Sinks and Rises
Strange Tale of a Buried Town

BOOK 4. Weather Secrets Simplified
Storms on Sun and Storms on Earth
The Strange Antics of a Ball of Fire

BOOK 5. Wonderland of Nature
The Regions of Frost and Fire
The Inside of an Active Volcano

***Volume II* — PARTIAL CONTENTS**
WONDERS OF POPULAR SCIENCE

BOOK 6. Pictorial Outline of Progress
Nearly Two Centuries of Steamships
Queer Forerunners of the Motor-Car
Development of Modern Locomotives

BOOK 7. Amazing Adventure in Science
Mystery of the Burning Glass
Marvels of the Electro-Magnet
Wonders of the Infra-Red Rays, etc.

BOOK 8. Seven Wonders of Modern World
How Telescopes Bring Things Near
How Microscopes Make Things Big
The Latest Methods of Television

BOOK 9. Manual of Simplified Experiments
Science Experiments for Everybody
Experiments With Simple Chemicals

BOOK 10. How Great Inventions Work
Inside of a Great Modern Steamship
A Big Coal Mine With the Lid Off
How a Submarine Sinks and Rises

***Volume III* — PARTIAL CONTENTS**
WONDERS OF LIFE

BOOK 11. Prehistoric Creatures
Life on Earth 30 Million Years Ago
Life on Earth 250,000 Years Ago

BOOK 12. Marvels of Plant Life
Plants That Catch and Eat Insects
Strange Freaks of Plant Growth

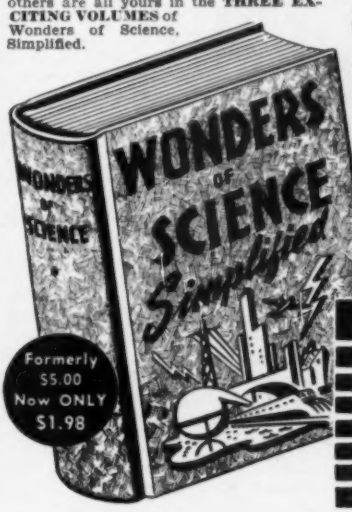
BOOK 13. Strangest Fish in the Sea
Some Nightmares of the Deep Sea
Queer Fishes That Crawl on Land

BOOK 14. The Animal Wonder Book
The Animal the World Nearly Lost
The Ugliest of All the Animals

BOOK 15. Man—Miraculous Machine
The Wonderful Way the Brain Works
What Your Body Looks Like Inside

WONDERS AND MYSTERIES OF SCIENCE IN THRILLING STORY AND 1,000 PICTURES

You can now enter the wondrous world of tomorrow. You can now go on thrilling tours through the wonderland of Science. Here is the telescope, the microscope, the spectroscope. Here are tours through talking picture studios and television studios. Here is aviation opening up the new world of speed and distance. And here, too, is the photo-electric cell, the marvelous eagle eye that will make men of the future supermen. These and hundreds of others are all yours in the **THREE EXCITING VOLUMES** of Wonders of Science, Simplified.



3 GREAT VOLUMES BOUND TOGETHER CONTAIN 1,000 PICTURES AND 15 BOOKS

This fascinating work contains three thrilling volumes bound together. It is packed with a thousand pictures which simplify its contents. Think of it—dozens and dozens, hundreds and hundreds of scientific pictures. Pictures of all kinds on Mechanics, Astronomy, Physics, Biology, etc.—dynamic diagrams, panoramic illustrations, and action-photographs up to 100 square inches in size! These hundreds and hundreds of dazzling illustrations cram three gorgeous volumes—and each of the three volumes is almost a foot high, and when opened, over a foot wide!

YOUR FRIENDS WILL ADMIRE YOU

Through the simplicity of the text, the tremendous record of Science is brought lavishly before you. The mightiest marvels of mankind thrill you as you read their stories. Invention, Geography, Zoology, Engineering, etc.—they are so simple and easy to understand. No wonder every person who has read and mastered this exciting wonderbook becomes a "walking encyclopedia" and is looked up to by his friends as a "scientific wizard."

BIG FREE OFFER—SEND NO MONEY

These three great, profusely-illustrated volumes of "Wonders of Science, Simplified" (bound together) formerly sold for $5.00. But it is offered to you now for only $1.98 plus postage. Act at once and we will include **FREE** with your order the 33 power long distance telescope lens kit described above. You take no risk because you must be 100% delighted or you may return for full refund within five days. **ACT NOW**—as this offer is limited to the supply of 33 power telescope lens kits available. This offer may never be yours again. So **RUSH COUPON AT ONCE.**

METRO PUBLICATIONS, Dept. 554
50 West 17th St., New York

Send me a copy of "Wonders of Science, Simplified" (three dazzling volumes bound together, over 1,000 illustrations) . . . also include my long distance telescope lens kit with this order. I will pay postman $1.98 plus postage on arrival. If I am not satisfied I may return them within five days for full refund.

NAME .....

ADDRESS .....

☐ Check here if you are enclosing $1.98, thus saving mailing costs (same guarantee).

What a difference, when you smoke the *Imperial* honeyed pipe

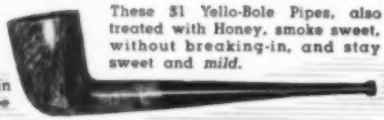
YES, THERE'S REAL HONEY in Imperial. Good enough to eat! Dear to the hearts of smokers everywhere because it entirely eliminates *"breaking-in"!*

HERE'S HOW THE HONEY IS SPRAYED IN the pipes. It coats walls of pipe-bowl *permanently*. It mingles with tobacco and forms a beautifully-cured "cake." A sweet, satisfying smoke, mild and smooth, *no matter what tobacco you use.*

Billiard Shape

$1.50

. . . and everybody knows that for $1, YELLO-BOLE is the finest pipe you can buy



Dublin Shape

These $1 Yello-Bole Pipes, also treated with Honey, smoke sweet, without breaking-in, and stay sweet and *mild*.

© 1942, Kaufmann Bros. & Bondy, 630 Fifth Avenue, N. Y.

Readers Say:

Has Doubts About Plastic Car Tops and Pennants for Waitresses

I ENJOY your magazine very much, as many of my schoolmates do. A number of us have model-airplane motors and we would like some articles on the maintenance of such motors. E. J. C., of Philadelphia, is slightly utsnay concerning his pennants for waitresses. A small musical bell would serve the purpose better and would not be in the way. Won't those cars with the plastic tops, be awfully uncomfortable with the sun streaming in?—L. E. W., Neptune Beach, Calif.

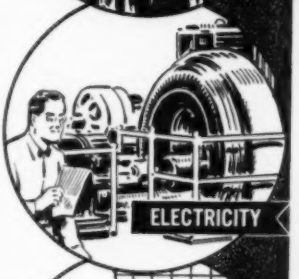
Pedals and Paddles for Power on Lifeboats and Rafts

MERCHANT seamen, aviators, fishermen, Marine Corps commandos—all could use lifeboats, rafts, and pleasure boats with foot-pedal paddle wheels mounted directly on the bottom instead of oars. Gasoline engines are taboo. A paddle wheel with an axle longer than the wheel's diameter will furnish more power than oars. Many such would supply adequate power for Army landing barges. Operation would be quiet, since the paddle wheel would always be completely under water.—P. E. D., Scranton, Pa.

A Glutton for Punishment, He Saves News Headlines

BEING intensely interested in the world news, I began saving the front page of our local newspapers. Although there were only one or two important headlines a week, the pages soon piled up. Since my hobby is taking pictures, I decided to copy these headlines. Not caring to build a copying table, I solved the problem by pinning the paper on the wall and placing the camera on a tripod. I place a photoflood in a reflector on each side of the newspaper to give a shadowless lighting. This work can be done with any kind of camera, but I think that one with a ground-glass focusing screen works best. I personally use a speed Graphic. I find it very interesting to look back in my files at the headlines that came out a year or two ago.—C. B., Denver, Colo.

Home Training helps YOU WIN!



Right Now

there is a tremendous shortage of skilled men in all branches of industry. Draftsmen, electricians, machine designers, tool makers, machinists are needed and the pay is big. Executives, too, foremen, superintendents, managers are wanted to help complete our tremendous production program.

War Production Demands Better Men

It is a duty you owe your country, yourself, and your family. You should know more and more about your job. You should be prepared to advance and to accept the responsibilities of the men ahead of you so that they in turn may climb and, climbing take you with them. No matter what your present job, you should learn to do it better or learn how to do the job of the man ahead of you. You need to know *both theory and practice* to make our tremendous war plants more productive. Yes, indeed, you *are* needed and *needed badly* right now.

Draftsmen, Electricians, Machine Designers, Machinists, Foremen, Superintendents, Managers Can All Profit by Home Study... No matter what your trade or profession there is a better place for you in industry. You can get the training needed right in your own home.

Use Spare Time, Learn At Home

As little as one-half hour a day can produce surprising results in giving you a better education, more practical and theoretical training which will be reflected in your pay envelope. Never in the history of the world have there been so many opportunities for trained men, nor has it been so easy to get this training. The American School was founded over 40 years ago to provide home study for men and women who missed the opportunity to go to high school or college and to make it possible for you to LEARN AS YOU EARN.

Rewards Are Great

Government figures show that graduates of specialized training of college grade, average over $40 per week more than grade school graduates. If you missed this college training, then here is your opportunity to get specialized training at home. More than 150 noted educators, engineers, and executives helped to prepare American School Courses. This instruction is now available to you at a relatively low cost and on *very easy* monthly payments. Write now for details. Clip and mail the coupon—there is no obligation.

AMERICAN SCHOOL
Dept. G846, Drexel at 58th St.,
CHICAGO, ILLINOIS

MARK, CLIP AND MAIL THIS COUPON NOW!

Get facts FREE..

(No Cost). All you have to do to find out about this type of training, to get the details and the outline of study, with histories of the successes of other men, is to send the coupon. There is no cost and no obligation of any kind. Let this great school, one of the pioneers in the home study field, explain the methods which can do so much for you. Get this information now so that you can get started quickly on the road to the fulfillment of a real ambition, and be of the greatest possible help in this present emergency.

AMERICAN SCHOOL
—Dept., G846 Drexel at 58th Street, Chicago—

AMERICAN SCHOOL, Dept. G846, Drexel at 58th, Chicago
Without obligation, Please send FREE and postpaid, bulletin and details of the Subjects checked.

- ☐ Air Conditioning
- ☐ Refrigeration
- ☐ Architecture and Building
- ☐ Plumbing and Steam Fitting
- ☐ Automotive Engineering
- ☐ Aviation Drafting
- ☐ Aviation Engineering
- ☐ Business Management
- ☐ Accounting and C.P.A.
- ☐ Cost Accounting
- ☐ Practical Bookkeeping
- ☐ Private Secretary
- ☐ Diesel Engineering
- ☐ Surveying & Topographical Drafting
- ☐ Sheet Metal Pattern Drafting
- ☐ Electrical Engineering
- ☐ Drafting and Design for Men and Women
- ☐ Radio
- ☐ High School
- ☐ Plastics
- ☐ Liberal Arts
- ☐ Mechanical Eng.
- ☐ Shop Management
- ☐ Tool Making
- ☐ Better Foremanship
- ☐ Engine and Boiler Work

Name.....*Occupation*.....
Address.....*Age*.....
City.....*State*.....

From the News Editor's Desk

AN "IMPOSSIBLE" SUBSTANCE, which cannot exist on the earth but apparently is abundant in the vast stretches of so-called "empty" space between the stars, partly clears up a mystery of long standing. It accounts for three of four spectral lines that have long puzzled astronomers. The substance is hydrogen carbide (or carbon hydride if you prefer). When starlight is analyzed in a spectrometer, lines in the rainbowlike spectrum indicate the presence of different chemical substances, which can be identified by comparison with the lines produced by known substances on the earth. Four of these lines, however, did not correspond to any known substance. It remained for two Canadian scientists, Dr. A. E. Douglas and Prof. G. Herzberg, to prove that three of them come from a substance with the formula CH, which cannot exist on earth because the normal quota of the carbon atom is four atoms of hydrogen. If it has less, it is "unsaturated" and on earth it can always find plenty of hydrogen atoms to fill its quota.

A TEN-HOUR TREATMENT for syphilis, using both arsenicals and artificial fever, is being tried experimentally on a few patients in the early stages of the disease. While it has not reached the point indicated by some prematurely enthusiastic reports, it is in line with the steady improvement in the treatment of this major disease of peace and war. Eighteen long months was the time formerly required to effect a cure, but six to 10-week treatments are now in practical use in over 50 clinics, including Government hospitals.

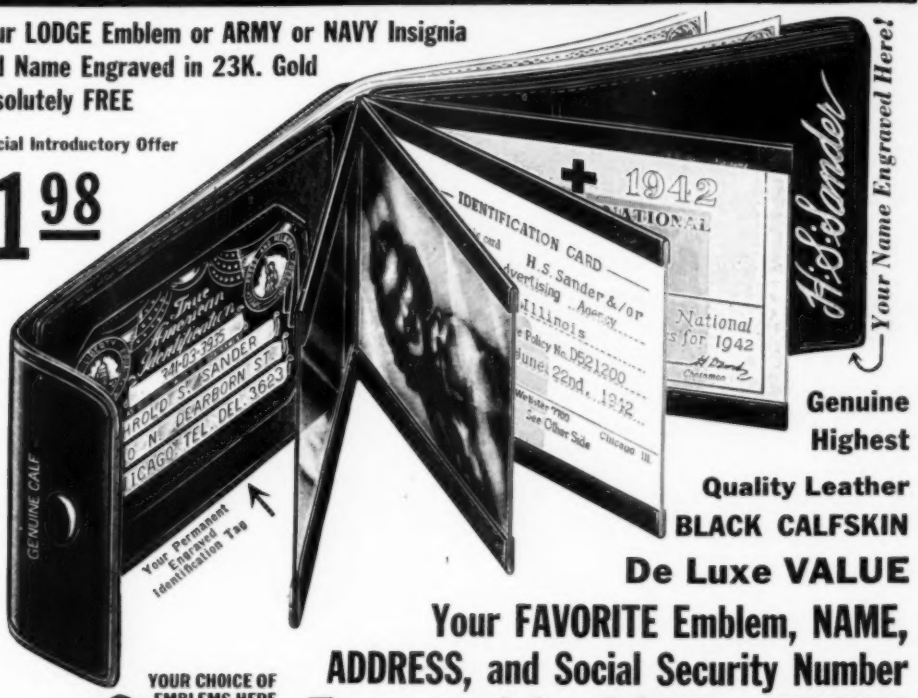
A PRINTING JOB STARTED 314 YEARS AGO has just been completed, setting a new record for delay in getting a book off the press. It was in 1628 that Fray Antonio Vásquez de Espinosa turned over to the printers a voluminous manuscript containing memoirs of his many years of life in the newly discovered countries of the New World. Part of it was actually put into type, then it went into the limbo of "lost books." For three centuries scholars have known of his interesting observations only through quotations by his contemporaries. Then an American scholar, Dr. Charles Upson Clark, stumbled upon the manuscript and the partially printed sections in the Vatican Library at Rome. Now completely printed in an English translation, it affords a rich mine of information for historians, anthropologists, geographers, and scholars in many other fields. Fray Antonio was an energetic, inquiring sort of person with an insatiable curiosity and a habit of quizzing missionaries, soldiers, officials, and traders whom he met in his travels. While he picked up a certain amount of misinformation along with his facts about the fabulous lands of the West, his book is one that the world will consider well worth waiting for—even for 314 years.

Here's the Greatest BILLFOLD BARGAIN in all America

Your LODGE Emblem or ARMY or NAVY Insignia and Name Engraved in 23K. Gold Absolutely FREE

Special Introductory Offer

$1.98



Genuine Highest Quality Leather BLACK CALFSKIN De Luxe VALUE

Your FAVORITE Emblem, NAME, ADDRESS, and Social Security Number Engraved in GOLD—FREE!

Men:—Here, without a doubt, is positively the greatest Billfold and Pass Case Bargain that you'll be likely to see for a good many years to come. For a high quality Calfskin Billfold, beautifully engraved in gold, with your LODGE Emblem or Army or Navy Insignia and Name, you would expect to pay up to $4.50 and consider it a marvelous buy. If you take advantage of this sensational introductory offer, you can get this superb genuine Calfskin Wallet and Pass Case for only $1.98, and we will send you absolutely free a specially designed three color lifetime Identification Plate, which carries your Social Security Number, your Name and Address or your Army Draft Number. This fine grain calfskin Billfold must actually be seen to be fully appreciated. Besides the spacious compartment at the back which can be used for currency, checks, papers, etc., it has four pockets each protected by celluloid to prevent the soiling of your valuable membership and credit cards.

When closed, this handsome Billfold has the soft velvety feel you find only in quality Calfskin. Your choice of Emblems and Initials, are beautifully embossed in 23 karat gold on the face of the Billfold. Due to difficulty in obtaining choice leather because of war conditions, the supply of these Billfolds is limited. Remember if you send your order promptly, we will include absolutely FREE, a beautiful identification Key Tag and Gilt Chain to match, all hand engraved with your Name, Address, City and State. If after receiving your Billfold and Free Gift, you don't positively agree that this is the most outstanding bargain you have ever come across, return them to us and your money will be cheerfully refunded in full. Send your order today, without fail so you won't be disappointed.

This beautiful three-color life-time Identification Plate carries your full name, address and social security or draft number.

Also FREE—If you order at once we send you this beautiful Identification Key Tag and Gilt Chain to match, hand engraved with your name, address, city and state. Will last a lifetime.

Rush This Coupon For This Once-In-A-Lifetime Bargain!

ILLINOIS MERCHANDISE MART,
Dept. 282, 54 W. Illinois St., Chicago,

If you want a LODGE, ARMY, NAVY, MARINE or AIR CORPS INSIGNIA, state name here Gentlemen: I enclose $1.98. Please send me a Genuine Calfskin Billfold with my name and choice of Emblems engraved in 23k gold. Include absolutely free a life-time Identification Plate carrying my full name and Social Security Number, or Draft Number. Also include FREE an Identification Key Tag and Gilt Chain to match, all hand-engraved with my Name, Address, City and State.

My Full Name ..... (Please print clearly)

Address .....

City ..... State .....

Social Security Number ..... Army Draft Number .....

☐ Please ship the above C.O.D. for $1.98 plus a few pennies postage and C.O.D. charges.

NEWS

Increased production means

MORE JOBS for MACHINISTS

and bigger pay for men who know their work

This big home-study and reference course gives you the practical facts on machines and methods you need to advance in machine shop work. Take advantage of the other man's experience as found in books, to solve your problems, increase your efficiency, with

The AMERICAN MACHINISTS' LIBRARY

6 volumes—2368 pages—2516 illustrations
(A combined home-study course and reference library)

This library of machine shop practice was written for practical men. It gives you the best methods for every kind of machine shop work. It fully explains lathes, drills, and other machine tools and their operation, automatic screw machines, speeds and feeds, gear design and production, jigs and fixtures, punch and die work, metal surfacing, etc., etc. Plainly written—completely illustrated—the best kind of help to the machine shop man who wants to advance himself.

No money down—special price—easy payments.

EXAMINATION COUPON

McGRAW-HILL BOOK CO., 330 W. 42nd St., New York

Send me for ten days' examination the American Machinists' Library. If satisfactory I will send you $1.50 in 10 days and $3.00 monthly until the price of $19.50 is paid. If not wanted, I will return the books postpaid. **(To insure prompt shipment write plainly and fill in all lines.)**

Name .....
Home Address .....
City and State .....
Position .....
Name of Company PSM-11-42

EVERY WORD CONTAINS A HIDDEN STORY OF ITS ORIGIN

Alert! Once meant, *On the watch-tower!*

ALERT, now meaning "air raid alarm!", comes from early French *à l'erte*, "on the watch." This, in turn, came from Italian *all'erta*, "on a watchtower or height." Both you *and your children* will enjoy the hundreds of fascinating word origins in WEBSTER'S NEW INTERNATIONAL DICTIONARY, Second Edition. Its completeness makes it truly *the Foundation Book for Home Education!* It seems almost unbelievable that such a vast fund of knowledge could be packed into one volume! And, in addition, you learn everything you want to know about words, 600,000 of them, 122,000 more than in any other dictionary. Ask any bookdealer to show you the MERRIAM-Webster, *identified by the Circular Trade-Mark*. Write for free illustrated booklet of interesting word origins to G. & C. Merriam Co., 125 Federal St., Springfield, Mass.

Advt. Copyright, 1942, by G. & C. Merriam Co.

THE GENUINE WEBSTER

WEBSTER'S NEW INTERNATIONAL DICTIONARY Second Edition

PARKS AIR COLLEGE

PARKS AIRPORT — EAST ST. LOUIS, ILL.

Offers YOU COLLEGE and PROFESSIONAL TRAINING Majoring in AVIATION

Accredited by the Illinois Superintendent of Public Instruction. Included since 1938 in The Directory of Colleges and Universities, issued by the U. S. Office of Education. U. S. approved as a Commercial Ground and Flying School and Mechanics' School. Accredited by and cooperating with the United States Army Air Corps in giving flight and mechanical training. Open to high school graduates. **FOUR courses lead to B.S. degrees in Professional Piloting, Aviation Operations, Maintenance Engineering, Aeronautical Engineering.**
TWENTY-TWO TRAINING PLANES are used in professional flight training which prepares graduates for airline flight operations.
FACULTY of 104 specialists in various fields of aviation.
Enrollment limited to a total of 300 commercial aviation students. Capacity enrollment of 870.
Airport, 25 buildings devoted to school purposes exclusively. Dormitories and dining hall at the College.
Winter term January 4. Send postcard for new 64-page catalog.

16th YEAR **Registrar, Dept. PS-11 PARKS AIR COLLEGE, East St. Louis, Ill.**

TRI-STATE COLLEGE

B. S. Degree in 2¼ Years

Distinguished for technical 2¼-year courses in Civil, Electrical, Mechanical, Chemical, Radio, Aeronautical Engineering; Business Administration, Accounting, and Secretarial Science. Special preparatory department for those who lack required high school work. Short diploma courses (36 weeks) in Surveying, Drafting. Low tuition. Low living costs. Cosmopolitan student body. **59th year.** Enter January, March, June, September. *Write for catalog.* **5112 College Ave., ANGOLA, INDIANA.**

DRAFTING

MORE DRAFTSMEN NEEDED in all manufacturing and building lines—$30 to $50 a week and UP. Learn *quickly* at home in spare time. *Selective Employment Service.* Write NOW for FREE Bulletin. No obligation.

American School
Dept. DD346, Drexel & 58th, Chicago

ANY BOOK IN PRINT!

Delivered at your door. **We pay postage.** Standard authors, new books, popular editions, fiction, reference, medical, mechanical, children's books, etc.—**all at guaranteed savings.** Send card now for Clarkson's 1942 Catalog.

FREE Write for our great illustrated book catalog. A short course in literature. The buying guide of 200,000 book lovers. The selection of a metropolitan book store brought to your home. **FREE** if you write **NOW—TODAY!**

CLARKSON PUBLISHING COMPANY
Dept. PS2 1253 So. Wabash Ave., Chicago, Ill.

Regain Perfect Speech, if you

STAMMER

Every stammerer should have the new 287 page book "Stammering, Its Cause and Correction". Sent free to stammerers. It describes the Bogue Unit Method for the scientific correction of stammering and stuttering. Method successfully used at Bogue Institute for 41 years—since 1901. Endorsed by physicians. Write for full information. No obligation.

Benjamin N. Bogue, Dept. 993 Circle Tower, Indianapolis, Indiana.

DO YOU

WANT a permanent business profession of your own? **Then become a foot correctionist.** Earnings of men and women in this greatly needed profession run as high as $50.-$100. weekly after a few weeks home training—not medical or chiropody—easy terms, no further capital needed, no goods to buy. 47th year. Write for free booklet.

Stephenson System of Foot Correction, 62 Back Bay, Boston, Mass.

PLAY TO WIN!

IN CARD OR DICE GAMES

Know when and how to play. Don't be a sucker! Amazing secrets help you to be more successful. Complete instructions with photographs, "How to Win with Fair Dice" *plus* "Monte Carlo Secrets"—181 subjects—100 ways to win—193 illustrations! Original price $5 each. SPECIAL $5 FOR BOTH! Order Now! H. C. EVANS & CO., Dept. 17-M 1520 W. Adams St., Chicago

FREE OFFER

The Most Remarkable AUTO REPAIR GUIDE Ever Published!

Mail coupon today for it—yours to Examine Free for 7 Days!

AUTO MECHANICS

USED BY U.S. ARMY

HERE, in one big, amazing 600-page volume, is ALL that anyone needs to know to do practically EVERY repair, tune-up, replacement job on every American car made since 1935, including 1942's—as well as major data for servicing 405 trucks!

It is the greatest collection of data and pictures on overhauling and adjusting today's cars ever compiled! Over 450 charts and tables! More than 900 photos, drawings and diagrams are in it!

So clear are its pictures and step-by-step instructions a child can almost understand it. Gives exact how-to-do-it on engines, lubrication, electric, fuel, cooling systems. Covers every service operation on clutch, transmission, universals, rear-end, wheels, brakes, knee action, shock-absorbers, springs, body, free-wheeling, etc. Try it at our expense for 7 days, and see for yourself!

Shows Every Mechanic, Even Experts, How to Save Repairing Time and Earn More Money TODAY!

Explains Every Repair Job on every Model of All These Cars—1935 through 1942!

	American Bantam	
Auburn	Graham	Oldsmobile
Austin	Hudson	Overland
Buick	Hupmobile	Packard
Cadillac	Lafayette	Pierce Arrow
Chevrolet	La Salle	Plymouth
Chrysler	Lincoln	Pontiac
Cord	Lincoln	Reo
De Soto	Zephyr	Studebaker
Dodge	Mercury	Terraplane
Ford	Nash	Willys

and major data on 405 trucks!

How This Book Helps You:

TUNE-UP: Step-by-step: instructions on the basic procedure.

CARBURETORS: Over 50 pages of text, charts, illustrations covering all models of carburetors.

TABLES: All important specifications, clearances, measurements, etc., arranged in handy form, including: TUNE-UP CHART • VALVE MEASUREMENTS • COMPRESSION PRESSURE TORQUE WRENCH READING • STARTING MOTOR • ENGINE CLEARANCE MAIN & ROD BEARING JOURNAL DIMENSIONS • GENERATOR • CLUTCH, BRAKE SPECIFICATIONS • FRONT END MEASUREMENTS

DETAILED INSTRUCTIONS ON:

ENGINES	WHEELS
ELECTRIC SYSTEMS	FRONT ENDS
FUEL SYSTEMS	KNEE ACTION
COOLING	SHOCK ABSORBERS
LUBRICATION	SPRINGS, BODIES
TRANSMISSIONS	FREE WHEEL, etc.

Published by MoToR, Book Dept., Desk 211, 572 Madison Ave. New York, N. Y.

ALMOST LIKE PERSONAL INSTRUCTION

Every job, from wheels to windshield wipers is covered. 50 pages of text, charts, cross-section diagrams on carburetors alone! Nearly 200,000 essential facts, each available on a second's notice through the Quick Reference Index. Sturdy waterproof binding that lasts for years.

150 OFFICIAL GUIDES ALL IN ONE BOOK!

Contains all essential information from the Official shop procedure manuals prepared by each car manufacturer's own engineers. Open the manual to the car you are working on, and everything you'll want to know is there before your eyes—Easy as A-B-C.

THOUSANDS NOW IN USE

This is the exact same shop guide used by the U. S. Army, and trade and technical schools all over the country for training auto mechanics. They long ago learned that no other book can compare with it. It is available *ONLY* through the MoToR Book Department.

Defense has drafted thousands of skilled mechanics. Good jobs are waiting *right now* for men who can step in and take their places. This is the book that can help you cash in!

SEND NO MONEY

Simply fill out and mail coupon below today and a copy of MoToR's up-to-the-minute 1942 Factory Shop Manual will be sent to you at once for 7 days' Free Trial. ACT NOW, while we still have plenty on hand for quick shipping.

MAIL COUPON FOR 7 DAY FREE TRIAL

MoToR BOOK DEPT., Desk 211, 572 Madison Ave., New York, N. Y.

Rush me MoToR's 1942 Factory Shop Manual. If O. K. I will remit $1 plus 35c shipping charge in 7 days, and $1 monthly for 4 months. ($5.35 in all.) Otherwise I will return book in 7 days. (Foreign price $6, cash with order.)

NAME_____ AGE_____

ADDRESS_____

CITY_____ STATE_____

OCCUPATION & EMPLOYER_____

☐ **SAVE 35c.** Check here if you enclose $5.00 ($6.00 Foreign) with coupon. We will then pay 35c costs. Same 7-day return privilege applies.

QUICK WAY TO LEARN MUSIC
—play any instrument

GET A REAL thrill out of music! Play the musical instrument you like best. Start right in with simple tunes. No tedious, old-fashioned drills and exercises.

It's easy! Everything is in print and picture. You see every position and move. Thousands have been amazed at their progress in just a few short weeks. Now they're sought-after guests for every party! Don't miss out on the popularity that is rightfully yours!

Mail coupon today for free illustrated Booklet and Print and Picture sample that show how easily and quickly you can learn music at home. Just check instrument that interests you. (Instruments supplied when needed, cash or credit). U. S. School of Music, 811 Brunswick Bldg., New York City.

FREE PRINT and PICTURE SAMPLE

U. S. School of Music, 811 Brunswick Bldg., N. Y. C.

Please send me Free Booklet and Print and Picture Sample. I would like to play instrument checked below. (Do you have instrument.....)

Piano	Accordion	Trumpet	Ukulele
Violin	Saxophone	Tenor Banjo	Other Instrument
Guitar	Mandolin		

Name .....

Street .....

City ..... State .....

AVIATION CAREER

Offers You

A GREAT FUTURE!

Complete Aeronautical Engineering or Master Aviation Mechanics training in the heart of the Aircraft industry. Graduates obtaining immediate employment. No flying involved. Aviation's foremost school, established in 1929. Located on Grand Central Air Terminal. For full information, address Department PS-11.

CURTISS WRIGHT TECHNICAL INSTITUTE

GRAND CENTRAL AIR TERMINAL
GLENDALE (LOS ANGELES) CALIF.

THIS TOWER OVERLOOKS AVIATION'S MOST DISTINGUISHED SCHOOL OF AERONAUTICS

Please mention POPULAR SCIENCE *when writing to advertisers.*

"Vacuum Tube" **HEAR a World of Sound Through This MAICO "ACE"**

Small as a pocket watch, yet enables hard of hearing person to carry on normal conversation at 20 feet — to hear even a whisper with loud noises cushioned.

FREE! Send name of relative, friend or your own name for a new experience in hearing. No obligation. Address Maico Co., Inc., Dept. 30-K, 2632 Nicollet Avenue, Minneapolis, Minnesota.

MAICO "ACE" Transmitter weighs only two ounces

A product of the Maico Company which provides 90% of America's precision hearing test equipment. Choice of ear physicians, hospitals, universities, clinics, airlines, U. S. Army and Navy.

Let MICKEY MOUSE

Cartoon HOME MOVIES be **Your** Xmas Greeting. Give and show Mickey, Donald Duck, Bosko, Three Monkeys, Oswald Rabbit. Also HOLLYWOOD FILM Comedies, Travelogs, Dramas and other features. 8MM and 16MM. Write for latest film releases or

SEE AT YOUR DEALER

HOLLYWOOD FILM ENTERPRISES, INC.
6060 Sunset Blvd. Hollywood, Calif.

AVIATION

MORE DRAFTSMEN NEEDED on planes, motors, equipment. Big pay. Special *Aviation Drafting* course trains you QUICKLY at home in spare time. FREE Bulletin. No obligation. Address
American School, Dept. A846, Drexel at 58th, Chicago

ARTISTS MAKE MONEY

Find out your ability. Send name, age, occupation and address for Free Vocational Art Test.

ART INSTRUCTION, INC., 11142 Art Instruction Bldg., Minneapolis, Minn.
(Formerly Federal Schools, Inc.)

Learn PHOTOGRAPHY at Home

Splendid opportunities. Prepare in spare time. Easy plan. No previous experience needed, common school education sufficient. Send for free booklet "Opportunities in Photography", particulars and requirements.

American School of Photography
1315 Michigan Ave., Dept. 1368, Chicago, Ill.

MATCHES ALWAYS DRY!

—If you carry a Marble's water-proof match box in your pocket. Absolutely water-proof —holds supply for several days. Made of seamless brass, ¾-inch in diameter. Only 60c at your dealer's, or sent postpaid. Get one today. Write for complete FREE Catalog.

[AS]

Marble Arms & Mfg. Company
5794 Delta Av. Gladstone, Mich. U.S.A.

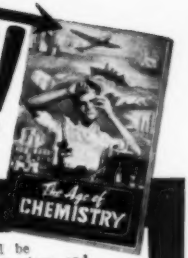
Asthma Agony Curbed First Day
For Thousands of Sufferers

Choking, gasping, wheezing Bronchial Asthma attacks poison your system, ruin your health and put a load on your heart. Thousands quickly and easily palliate recurring choking, gasping Bronchial Asthma symptoms with a doctor's prescription called **Mendaco**, now distributed thru drug stores, to help nature remove thick strangling excess mucus and promote welcome restful sleep. **Mendaco** is not a smoke, dope or injection. Just pleasant tasteless tablets. Iron clad guarantee—money back unless satisfactory. **Mendaco** is **only 60c** at druggists.

IT'S FREE!

Don't Miss This up-to-the-minute **NEW BOOK**

"THE AGE OF CHEMISTRY"



This age of chemistry may well be called "the age of opportunity" for boys and girls who become interested in chemistry. Every industry and home in America uses new and better products produced by our big chemical plants and made possible by the discoveries of Modern Chemistry. This new book describes many mystifying experiments you can perform to amaze your friends and tells you about the wonders of Chemistry. Write today—it's FREE.

THE PORTER CHEMICAL CO., 44 PROSPECT AVE., HAGERSTOWN, MD.

New York Electrical School

Established 1902

Ask for free illustrated booklet

40 West 17th St., N. Y. C.

Correspondence Courses In RADIO and ELECTRICAL ENGINEERING

LOW AS $25

ELECTRICAL ENGINEERING. Get good grasp of wide electrical field. Modern. Very understandable. Theory made easy.
RADIO ENGINEERING. Extra fine course in radio, public address, photo-electric work. Trains you to be super-service man, real vacuum tube technician. Tuition ONLY $25, either course. Deferred payment plan. Experiment kits furnished.
FREE Write for free copies of school catalogs, student magazines, etc.
LINCOLN ENGINEERING SCHOOL, Box 931-S47, Lincoln, Neb.

LAW

STUDY AT HOME for PERSONAL SUCCESS and LARGER EARNINGS. 31 years expert instruction—over 106,000 students enrolled. LL.B. Degree awarded. All texts furnished. Easy payments. Send for FREE BOOK—"Law and Executive Guidance".

AMERICAN EXTENSION SCHOOL OF LAW
Dept. 23-S, 8 East Huron St., Chicago, Ill.

OTTAWA LOG SAW $39 BIG BOOK FREE

PUTS THIS **OTTAWA** to work for you. **MAKE MONEY!** Wood is valuable. Does more than 10 men. Easily operated. Falls trees—saws limbs. Use 5-hp. engine for other work. Write for **FREE Book.**
SAW 10 TO 20 CORDS A DAY
OTTAWA MFG. CO.
2601 Wood St., Ottawa, Kans.

MONEY IN RABBITS—CAVIES

WE BUY and put you in touch with other markets. Catalog and copy of magazine 10c. Or send 25c for Book Catalog and Price List and Year's Subscription to the AMERICAN SMALL STOCK FARMER.
OUTDOOR ENTERPRISE CO., BY822, Pearl River, N. Y.

Expert training for industry jobs

New book trains you to **read blueprints,** use **precision instruments,** work with **all kinds of metal, wood, plastics.** Handy pocket size, 288 pages, **154 illustrations.** HOW TO GET AHEAD IN A DEFENSE PLANT, sent C.O.D. for 5 days examination. Return book for refund if dissatisfied. T. Y. Crowell Co., 432 Fourth Ave., N. Y.

TOTAL COST **$2.50**

BOWS·ARROWS·MATERIALS

HANDBOOK—How to Make and Use Bows and Arrows—90 Pages well illustrated (with catalog) 35c.
CATALOG—100 pictures—color spread—Instruction Folder. 10c.
CATALOG alone 5c. Stamps or Coin.
L.E.STEMMLER, QUEENS VILLAGE, N.Y.

ACCOUNTANCY

One of America's best paying professions

These Are OPPORTUNITY DAYS for the Trained ACCOUNTANT!

WITH war, state and federal legislation requiring more accurate accounting from businesses than ever before, the trained, successful accountant is certainly a man to be envied. Much in demand, member of "America's best-paid profession," an important figure in affairs, he is one of the most influential and *necessary* individuals in the whole business scheme!

His is a profession YOU may be considering at this moment. If so, don't fail also to consider critically how, when, and from whom you will secure your Higher Accountancy training. Consider particularly LaSalle's record of more than 500,000 Accountancy-trained men and women during the past thirty-four years—a record unsurpassed by any other educational institution.

Remember, too, how numerous are the available accountancy schools and courses in the country. Yet, despite this fact, *approximately one-tenth of all C.P.A.'s* have been student members of LaSalle.

As to the training itself, you will find it absolutely complete; from Practical Accounting through to Accounting Systems, and Income Tax Procedure, including C. P. A. Coaching that qualifies you thoroughly.

Spare-time study does it all! No interference with your present work and a careful analysis of thousands of student histories reveals that some have realized, in increased later earnings, as high as $50 returns on every hour devoted to such study.

If you are actually in earnest—are willing to work devotedly for your future success, look into this subject carefully, thoughtfully, and from every angle. Full information and a 48-page survey of every opportunity field will be sent you on request.

Sign and mail coupon for complete details

LASALLE EXTENSION UNIVERSITY
A Correspondence Institution

Dept. 1183-HR **Chicago**

Kindly tell me more about the war opportunities in Accounting and how your training can help me grasp them. Also send me—free—your booklet on "Accountancy, the Profession That Pays."

☐ Higher Accountancy

Other LaSalle Opportunities:

If more interested in one of the fields indicated below, check and mail now.

☐ Business Management
☐ Modern Salesmanship
☐ Law—Degree of LL. B.
☐ Commercial Law
☐ Expert Bookkeeping
☐ C. P. A. Coaching
☐ Traffic Management
☐ Stenotypy

Name.....

Present Position.....

Address.....

ELECTRICAL BOOKS shipped FREE

10 BIG BOOKS

FOR EXAMINATION
MODERN ELECTRICITY INCLUDING RADIO AND TELEVISION

Here's great news for anybody interested in Electricity. NEW 18th edition of Applied Electricity brought right down to date with NEW Electrical subjects fully covered, including Electrical Blue Print Reading. 10 big Volumes and all shipped **FREE** for examination.

1942 Edition
FOR BEGINNERS AND EXPERTS

over 3,000 pages—hundreds of illustrations—the most complete work of its kind we have ever published. Dynamos, motors, power stations. Radios, television, everything electrical explained so anyone can understand it.

BIG FIELD! Big Demand! Big Pay!

Men who understand electricity are urgently needed in thousands of **war production** industries. Airplanes, shipbuilding, arms plants, machine shops—practically every industry depends on electricity and men who know this subject make big money. Pleasant, fascinating work, easy to learn and do; learn with these books. Send coupon for a set for **FREE** examination and see for yourself.

SEND NOW A year's consulting privileges with our engineers now given to all buyers of this famous Cyclopedia of Electricity.

AMERICAN TECHNICAL SOCIETY
Vocational Publishers since 1898

American Technical Society, Dept E820, Drexel at 58th St., Chicago

Send for 10 days' free use, 10 volume set of **1942 Edition** Applied Electricity, including a certificate entitling me to consulting privileges for one year. I will pay the delivery charges only on the books. If I wish I may return them in 10 days and owe you nothing, but if I keep them, I will send $2.00 after 10 days, then $3.00 a month until the total price of only $29.80 is paid.

NAME .....

ADDRESS .....

CITY ..... STATE .....

Please attach letter stating age, occupation and name and address of employer and give at least one business man as reference.

RADIO

ENGINEERING, broadcasting, aviation and police radio, servicing, marine and Morse telegraphy taught thoroughly. 48 weeks' engineering course equivalent to three years' college radio work. School established 1874. All expenses low. Catalog free.

The Dodge Institute, 503 Monroe St., Valparaiso, Ind.

Class Pins and Rings

Artistic pins, rings and emblems. Finest quality. Reasonable prices from 55c up. Write today. **Dept. O. Metal Arts Co., Rochester, N. Y.**

FREE Catalog

Learn Mount BIRDS to

LEARN AT HOME Be a Taxidermist

Real **FUN**, great Hobby, sure spare-time profits. Save your hunting trophies. Mount **BIRDS, ANIMALS, HEADS, FISH, FANS** furs and hides. Mount common specimens into fine groups. Wild-game not needed. Easily, quickly learned. Investigate!

FREE BOOK Yes **FREE**, 100 pictures. Tells how **YOU** can be a Taxidermist, make a home museum, have fun and **PROFIT** from your **HOBBY**. Old reliable school, 250,000 successful students. Students earn **BIG PROFITS** mounting specimens for others. This strange **FREE BOOK** will interest and amaze you. Nothing like it—Send **TODAY**—this **MINUTE**—for **YOUR** Free copy. State your **AGE.**

N. W. School of Taxidermy, 3398 Elwood Bldg., Omaha, Neb.

Lower Cost BUILDING MATERIALS

You can help to conserve metals, lumber and transportation in your locality by making building products out of non-essential materials. These raw materials are available everywhere without priorities, and your market is right in your own territory.

You can serve a wide market, comprising big or small jobs for building or remodeling. Buildings must be repaired—small additions must be built. To do this work, they need materials. Get ready to manufacture and supply this need.

You can still equip yourself at low cost to supply this market now and, at the same time, form the foundation for an attractive future manufacturing enterprise.

Write today for Catalog No. 72. It tells the whole story.

CONCRETE EQUIPMENT COMPANY
519 Ottawa Ave. Holland, Michigan

I WISH I HAD SOME SPENDING MONEY
HERE'S MY CHANCE I'LL MAIL THE COUPON
BRING A COLLIERS EVERY WEEK
NOW I HAVE MONEY AND MANY BIG PRIZES

G-MAN OUTFIT

Boys, earn a G-Man set, microscope, movie, athletic equipment, or any of 200 other prizes. Make MONEY, too.

It's easy. Deliver Collier's to customers you obtain near home. Do it in spare time. To start, write TODAY giving your age, to Jim Thayer, Dept. 964, The Crowell-Collier Publishing Co., Springfield, Ohio.

FREE BARGAIN CATALOG of BOOKS

25,000 books of all publishers listed in our 48th Annual Bargain Catalog of 320 pages. Old-time favorites—latest "best sellers." Reference, Fiction, Juvenile, History, Scientific, etc. Supplying schools, colleges, libraries and thousands of individual customers. **Send postcard today for our new 1943 catalog, "Bargains in Books."**

THE BOOK SUPPLY COMPANY, DEPT. 146
564-566 West Monroe St. Chicago, Ill.

Begin today. Write now for our Free Book, "How to Become a Good Penman." It contains specimens and tells how others learned to write in spare time. Enclose 10c for your name beautifully written and a pen point suitable for shaded writing. Write today.
THE TAMBLYN SCHOOL OF PENMANSHIP
X489 Ridge Building, Kansas City, Mo.

MIND DISCOVERY

Discover new powers in your mind. Our Stimulators awaken you. First FREE as Introduction to Revelations Course. Write at once for Stimulator A while supply lasts. SELF ADVANCEMENT INSTITUTE, 99 Fern Street, Philadelphia, Pa.

Wonders Through The MICROSCOPE

A new book which tells you all about MICROSCOPY. Turn an inexpensive microscope on hundreds of specimens within a stone's throw of your front door and you step off into a new world of wonders. Complete Manual for amateurs. How to use equipment, secure and preserve specimens, take photomicrographs, etc. Numerous illustrations. Full cloth bound $1.00.

POPULAR SCIENCE MONTHLY, Dept. 112A
353 Fourth Ave. New York, N. Y.

"LANGUAGE IS A WEAPON"

• • • Forge ahead, win special assignments, in global war and the ultimate peace, through ability to speak a foreign language.

MASTER ANOTHER LANGUAGE
quickly, easily, correctly
by LINGUAPHONE

The world-famous Linguaphone EAR-EYE Conversational Method brings voices of native teachers INTO YOUR OWN HOME. No English is spoken. You learn the new language by LISTENING.

Home-Study Courses in 29 Languages.

RUSSIAN JAPANESE SPANISH
PORTUGUESE CHINESE NORWEGIAN
and 23 others

Send for FREE book

LINGUAPHONE INSTITUTE
58 RCA Building, New York • Circle 7-0830

Learn TOOL DESIGN

Qualify quickly as a Machine or Tool Designer by home study in spare time. Entire defense program depends largely upon the machine and tool designer. After defense boom, machine and tool designers will be equally necessary for reconstruction. Many now making $100 to $125 a WEEK. Rapidly expanding industry calling for more machine and tool designers than now available. Learn quickly with our step-by-step lessons supervised by a recognized professor of machine tool design. Rush name and address today for complete facts on Machine or Tool Design. Learn what these fields offer you and how quickly you can qualify for a big pay position. No obligation. State age. A penny postal will do—but hurry.

DEFENSE JOBS CALLING

Ohio Institute of Technology, Box 80, Greenville, Ohio

New Catalog

GENUINE U. S. BARGAINS

O. D. Wool Blankets (used) . . . $2.95
McClellan Saddles (used) 5.95
U. S. Army Pup Tents (used) . . . 3.50
Aluminum Mess Pans (used) 35

Thousands of other bargains in military, outdoor & sport goods for hunter, farmer, scout. Send 10c for 32 page catalog returned with first order.

A and N SUPPLY CO.
4784 LESTER ST. RICHMOND, VA. EST. 1898

STUDY AT HOME

With A Chartered Educational Institution

Courses in ENGINEERING: Electrical, Civil, Mechanical, Drafting, Architectural, Steam, Aeronautical, Radio, Structural, Mining, Industrial, Highway, Petroleum, Marine, Chemical. **Courses in ARTS AND SCIENCES:** Philosophy, Education, Public Health, Medical Jurisprudence, Psychology, Sociology, Physics, Chemistry, Geology, Political Science, Theology, Law, Business and Commerce, Accounting, Mathematics, Statistics, Agriculture. **McKinley-Roosevelt, 4610-BAC Sheridan Road, Chicago**

$5 FOR YOUR PICTURE!

Universal-trained men and women everywhere selling their photographs for $5 and more each—earn $15 to $50 EXTRA every month! Home Study photo-journalism course teaches you what to take, how, and where to sell photographs. FREE Book gives details. **UNIVERSAL PHOTOGRAPHERS, Inc., Dept. 3, 10W. 33St., New York City**

PINS RINGS FOR YOUR CLUB!

Beautifully Styled-Low Prices!

Make your members more conscious of their membership. Write for free catalog. Shows 300 styles, sterling and gold plate on sterling. Choose a design suitable for your group. No order too small. Quality leader for 48 years. Write today!

BASTIAN BROS. Dept. 92, Rochester, N. Y.

WINDOW SIGN LETTERS

For Store Fronts and Office Windows. Anyone can put them on. Free Samples. Liberal Offer to general agents.

METALLIC LETTER CO., 440 N. Clark St., Chicago

Get into the BAKING BUSINESS

Bakers make good money! Now 7th Industry in wages! Nearly depression-proof. New home study Baking Course qualifies you. Common school education sufficient. If you're ambitious, write for FREE BOOK, "Opportunities in Baking."
National Baking Institute, 1315 Michigan, Dept. 1368, Chicago

MONEY for MEN ALL DATA FREE

THE PLASTEX Industry needs manufacturers on small scale and for big production of Lamp and Clock Stands, Art Goods and Novelties in Plastex and Marble imitation. Experience unnecessary. Lac material makes regular 10c store sellers. Rubber moulds furnished for speed production. Small investment brings good returns. Big chain store orders now being placed. Ambitious men have chance for real prosperity. Our Free booklet will interest and benefit you.

PLASTEX INDUSTRIES, Dept. 2, 1085 Washington Ave., New York, N.Y.

More GOOD JOBS in DRAFTING

in AIRCRAFT and other War Industries!

Calls for Draftsmen Are Increasing! . . . Read the want-ads for proof of this urgent demand.

This complete drawing outfit, — every thing to work with,—including drafting table, drawing board, supplies, etc.— ALL SENT TO YOU AT NO EXTRA COST if you are a Chicago Tech Student.

MAIL COUPON BELOW

The War Production program has increased the demand for Aircraft Draftsmen, Machine Draftsmen, Architectural Draftsmen, Electrical Draftsmen, and Structural Draftsmen. The Draftsman always comes first on any new project in manufacturing and industry—peace or wartime.

The Draftsman—"The Key Man" in War or Peacetime Industry

No new machines can be built, no airplanes constructed, no bridges or buildings erected, no ships or submarines launched until the draftsman has completed his work. Real immediate opportunities exist in Drafting—the profession upon which all construction is vitally dependent. Drafting is clean, interesting, well paid work. Steady employment. Investigate today what Drafting offers you! Help your country in a vital War production job on the important Home Front—and help yourself to a well paid job in Drafting.

Learn in Spare Time,—at Home!

(or at the College in Chicago)

With our easy step-by-step lessons, (and the tools we furnish), you can learn in your spare time at home. Convenient terms. To prove to you how easy it is to learn Drafting by the Chicago Tech Method we'll send you a Trial Lesson FREE. No charge for this lesson either now or later. Send a post card or the coupon now for

free TRIAL LESSON ***Send Coupon***

CHICAGO TECHNICAL COLLEGE

P-218 Tech. Bldg., 2000 S. Michigan Ave., Chicago, Ill.

Please send me **FREE Trial Lesson in DRAFTING** showing how to learn at home by C. T. C. plan for good job in aircraft and other war industries. No obligation of course.

Name.....

Address.....

City..... State.....

Occupation..... Age.....

GET ON THE TECHNICAL FRONT

MEN OF ALL AGES

SHOP METHOD HOME TRAINING

BE AN ENGINE EXPERT

Quick preparation for Civilian and U. S. Govt. Service. Established resident school offers tested Home Training in DIESELS, GASOLINE ENGINES, MECHANICAL SERVICING and ENGINE RE-MANUFACTURE. Learn repair, operation, trouble-shooting, ignition and maintenance by fascinating and profitable shop method Home Training. Not a dull moment. Close supervision by experienced instructors. Big demand during war and in reconstruction afterwards. MAIL Coupon for FREE Lesson and Opportunity Book.

MAIL COUPON FOR FREE LESSON & BOOK

NATIONAL SCHOOLS

LOS ANGELES, CALIF. (Est. 1905)

MAIL OPPORTUNITY COUPON FOR QUICK ACTION

National Schools, Dept. 11-PS
4000 S. Figueroa, Los Angeles, Calif.

(Mail in envelope or paste on penny postal.)

MAIL me FREE, without obligation, one Lesson and Opportunity Book, with full details about how I can become an Expert Engine Technician.

NAME _____ AGE _____

ADDRESS _____

CITY _____ STATE _____

Make BIG MONEY AT HOME!

NEW Invention **Electroplates by BRUSH**

Now Plates CHROMIUM!

ALSO GOLD, SILVER, NICKEL, COPPER, ETC.

War Increases Demand—You Profit!

New, patented invention makes possible big earnings AT HOME. Replate auto-parts—worn articles in homes, stores, hotels, restaurants, etc., with durable, sparkling, new coat of metal—with stroke of brush. Easy, simple, quick. Genuine Gold, Silver, Nickel, Cadmium, etc. Everything furnished. Outfit complete, ready for use. No shop required. Clear from $2 to $5 an hour in lifetime business. Small investment starts you in business. Steady repeat. Machine can pay for itself in week. Send TODAY for FREE SAMPLE and illustrated BOOKLET how you can have a life income from a business of YOUR OWN built upon satisfied customers. Act at once!

WARNER ELECTRIC COMPANY
215 W. Ohio St., Chicago, Ill., Dept. 224

FREE BOOK & SAMPLE

WARNER ELECTRIC CO., 215 W. Ohio St., Chicago, Ill., Dept. 224
Gentlemen: Send me Free Sample and Illustrated Booklet.

Name _____

Address _____

City _____ *State* _____

LEATHERCRAFT HEADQUARTERS!

We have plenty of leather

Make useful leather items for yourself OR gifts for others.

Belts, Purses, Gloves, Moccasins, Desk Sets, Book Binders . . . easy to assemble. 101 practical suggestions in 16-page catalog. Send 10 cents. Write today.

J. C. LARSON CO.
180 W. Wacker Drive, Dept. 5, Chicago, Illinois

2 Kinds: *Mediums*—for light Beards; *Strong*—for heavy Beards. State kind desired.

MEN! At Last You Can Now

REMOVE YOUR BEARD

—Without Razor or Blades —With NEW—

MIRACLE SHAVING POWDER

Works in 3 minutes. Endorsed by physicians who have tried it as far superior to razor shaving. Tends to slow down beard growth. Men who used to shave daily now use this powder only 2 or 3 times a week . . . Send $1 for enough for about 50 times.

LEE, Box 3620-PS Merchandise Mart, Chicago, Ill.

A BIG FISHING BOOK FOR ONLY 25c!

Chock full of information and advice on every type of fishing! How to find and use natural baits, how to handle all kinds of artificial lures. Instructions on trolling, fly fishing, skittering, bait casting, ice fishing, and ocean fishing—with pages and pages of helpful suggestions for catching trout, salmon, black bass, pike, panfish and many others. 84 pages. Fully illustrated. Send only 25c for your copy *today!* Address Dept. 112.

POPULAR SCIENCE MONTHLY
353 Fourth Ave. New York, N. Y.

When Writing Advertisers
Please Mention POPULAR SCIENCE

WOOD CARVING and WHITTLING

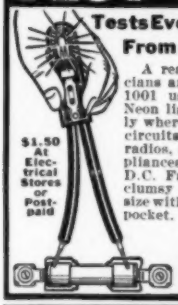
AN ARTISTIC HOBBY FOR ALL

This new manual shows you how to do every kind of wood carving. How to carve jewel boxes, picture frames, trays, chests, furniture, etc. How to do chip carving, level surface carving, incising, carving in relief. Carving human and animal figures in the round completely explained and simplified. 256 Pages. Fully illustrated,—full cloth bound. Send only $2.00 and your copy will be sent postpaid, or order COD plus postage if you wish. *Money back if not satisfied.*

Popular Science Monthly—Dept. 112
353-4th Ave. New York, N. Y.

TEST-O-LITE

Tests Everything Electrical From 100 to 550 Volts APPLIANCES



$1.50 At Electrical Stores or Postpaid

A real necessity for electricians and home because it has 1001 uses. Equipped with a Neon light which tells instantly where trouble lies in electric circuits, fuses, cut-outs, motors, radios, all kinds of electric appliances, etc. Tells A.C. from D.C. Far superior to ordinary clumsy test bulb. Fountain pen size with clip for carrying in vest pocket. Lifetime guarantee.

MOTORS

FUSES

PATENTED

L. S. BRACH MFG. CORP.
53 Dickerson St., Newark, N. J.

ENGINEERING DEGREE IN 27 MONTHS

INDIANA TECHNICAL COLLEGE

Courses in Aeronautical, Chemical, Civil, Electrical, Mechanical, and Radio Engineering. One-year courses in Radio and Drafting. Approved by C.A.A. Prep courses without added cost. Low tuition. Large industrial center. Opportunity to earn part living expenses. Enter December, March, June, September. Catalog.
6112 E. Washington Blvd., Ft. Wayne, Ind.

ELECTRICAL TECHNICIANS

URGENTLY NEEDED!

In industry—in Army and Navy—electrical technicians win better jobs and ratings. Learn fundamentals of electrical theory and practice—testing, drafting, machine shop, wiring, control. **Course complete in one school year.** Dormitory; dining hall; campus. 50th year. Send for catalog and Vocational Chart.
111 Takoma Ave., Washington, D. C.

BLISS ELECTRICAL SCHOOL

High School Course at Home

Many Finish in 2 Years

Go as rapidly as your time and abilities permit. Course equivalent to resident school work—prepares for college entrance exams. Standard H.S. texts supplied. Diploma. Credit for H. S. subjects already completed. Single subjects if desired. High school education is very important for advancement in business and industry and socially. Don't be handicapped all your life. Be a High School graduate. Start your training now. Free Bulletin on request. No obligation.
American School, Dept. H-846, Drexel at 58th, Chicago

THERE'S MONEY IN **CARTOONS!**

RAYE BURNS will teach you HOW to CREATE ORIGINAL CARTOONS at home that you may SELL! Course contains 26 lessons and over 600 illustrations. All for *Only*..

$2.85

Send name and address for free details.

RAYE BURNS SCHOOL, Dept. S, Box 1298, CLEVELAND, OHIO

don't WORRY

ABOUT RUPTURE

Why put up with years of needless discomfort and worry? Try a Brooks Automatic Air Cushion. This marvelous appliance permits the opening to close, yet holds reducible rupture securely, comfortably—day and night. Thousands report amazing results. Light, neat-fitting. No hard pads or stiff springs to chafe or gouge. Made for men, women and children. Durable, cheap, **Sent on trial** to prove it. Never sold in stores. Beware of imitations. Write for Free Book on Rupture, no-risk trial order plan, and proof of results. All correspondence confidential.
BROOKS COMPANY, 160-B State St., Marshall, Mich.

INVENTORS

Get this **FREE** → *Expert Advice*

ON HOW TO **PATENT** *and* **SELL YOUR INVENTION**

ACT QUICK—DELAY CAN BE DANGEROUS

If you have an invention—if you feel that it is commercially valuable and want to protect your rights to profit from it—send for our Free "PATENT GUIDE FOR THE INVENTOR"—NOW! For a good practical invention, plus prompt action in securing a Patent and locating a buyer or a good market, have proved the secrets of success for thousands of inventors.

"PATENT GUIDE" SHOWS WHAT TO DO

Our "Patent Guide" answers many important questions concerning Patents. It tells what facts, details, drawings, sketches, etc. are necessary to apply for a Patent; how to establish proof of your invention through dated and witnessed disclosure. We also send you our FREE "Record of Invention" Form and show you how to USE IT AT ONCE, without cost, before you file Patent Application. Our Guide also shows you how Patent Office Records can be checked to determine whether an invention is probably patentable before filing fees need be paid; discusses costs involved and a practical way these can be paid in installments as the application progresses through our office. It tells how some inventors secured financial backing; how many simple inventions proved large commercial successes; how patents covering improvements can be profitably protected and marketed; tells countless other facts of vital interest to ALL inventors.

Remember—in Patent matters DELAY CAN BE COSTLY—ACTION IS IMPORTANT. Mail the Coupon NOW—in an envelope or pasted on a penny postcard to: CLARENCE A. O'BRIEN and HARVEY B. JACOBSON, Registered Patent Attorneys, 22-L Adams Building, Washington, D. C.

CLARENCE A. O'BRIEN and HARVEY B. JACOBSON

CLARENCE A. O'BRIEN and HARVEY B. JACOBSON
Registered Patent Attorneys before the United States Patent Office
22-L Adams Building, Washington, D. C.

Please send me your 48-Page "Patent Guide for the Inventor" and your specially prepared "Record of Invention" form **FREE**. This request does not obligate me.

Name .....

Address .....

City ..... State .....

(Please write or print plainly.)

New Thrills for Model Railroaders!

Hundreds of new ideas that will save you money and make model railroading more fun than ever! Shows how to lay your own track, how to make automatic signal systems, culverts, roundhouses, tunnels, switches and other modern railroad equipment.

It's easy to follow the clear, simple instructions and diagrams in this new book. Shows how to make freight cars, baggage cars, pullmans and day coaches. In addition, there's complete instructions and blueprints for building a Pennsylvania R. R. type locomotive.

SEND NO MONEY NOW

Just write for your copy of MODEL RAILWAYS today, and pay the postman only $2.00 plus a few cents postage on delivery. If you prefer to remit now we pay postage. Money back if not satisfied. Address

POPULAR SCIENCE MONTHLY—Dept. 112
353 Fourth Avenue • New York, N. Y.

When Writing Advertisers
Please Mention POPULAR SCIENCE

NOW READY! LIONEL CATALOG

Just off the press—big, new full-color Lionel Catalog. Send for your free copy at once. Use the coupon below.

FREE! FREE! FREE! FREE!

LIONEL, Dept. 1, 15 East 26th St., New York, N.Y.
Please rush me free copy of new 1942 Lionel Catalog.
Name_____
Address_____
City_____ State_____

THRILLS AND MONEY, TOO— IN SCIENTIFIC CRIME DETECTION

ARE Yours

Easy and Inexpensive to Learn

AT HOME Fascinating; exciting; big steady pay! Be a Finger Print Expert. It's a SCIENCE which, when mastered THROUGH I. A. S. training gives you a lifetime vocation. Rapidly expanding field offers fine opportunities. Course includes the most modern methods in Scientific Crime Detection. 43% of all Identification Bureaus in U. S. A. headed by our graduates. Learn how you, too, can qualify for such pleasant, profitable, thrilling work. Send for our *free* Crime Book and full particulars about I. A. S. training, now.

FREE! "THE BLUE BOOK OF CRIME" It's full of exciting information on Scientific Crime Detection. Tells you how, at small cost, you can get started in this important work. Write for it today, stating age.

INSTITUTE OF APPLIED SCIENCE
Dept. 1368, 1920 Sunnyside Avenue, Chicago, Illinois

WINN'S NEW IDEA HOME LABORATORY CHEMICAL KITS

For High School & College Students. Send 5c for Literature and Retail Supply Catalog.

J. H. WINN MFG. CO., Dept. 111
124 W. 23 St. New York, N. Y.

NEW Grinding Attachment

For 8" to 16" Metal Lathes. Build It Yourself.

At last, a precision grinder within your means. You save 2/3 by finishing our semi-machined castings, on your own lathe. HURON handles both *internal* and *external* grinding. Accuracies to .0005". Mirror finish easily obtained. Grinds *valves, pistons, bushings, shafts*, hard or soft, *holes, lathe centers. Sharpens reamers, milling cutters. Does eccentric drilling; lapz polishes;* scores of other uses, for home workshops, garages, machine shops. Write for *FREE* illustrated folder and price list of supplementary items. Mention your lathe.

Semi-Machined Castings

Huron Machine & Tool Co., Dept. C-11, Yale, Mich. Only $6.45

RAISE GUINEA PIGS

MAKE MONEY. Thousands needed—War demand great. We supply breeders and buy the young. Write today for FREE illustrated bulletin. **RESEARCH SUPPLY CO., Dept. D-3, 2436 W. York St., Phila., Pa.**

SEND 10¢ FOR CATALOG

DICE • CARDS

Perfect Dice, Magic Dice, Magic Cards—*READ THE BACKS*—Inks, Daubs, Poker Chips, Gaming Layouts, Dice Boxes, Counter Games, Punchboards. WRITE FOR CATALOG TODAY.

K. C. CARD CO. 1222 W. Washington Blvd., Chicago, Ill.

Kidneys Must Clean Out Acids

Excess acids, poisons and wastes in your blood are removed chiefly by your kidneys. Getting up Nights, Burning Passages, Backache, Swollen Ankles, Nervousness, Rheumatic Pains, Dizziness, Circles Under Eyes, and feeling worn out, often are caused by non-organic and non-systemic Kidney and Bladder troubles. Usually in such cases, the very first dose of **Cystex** goes right to work helping the Kidneys flush out excess acids and wastes. And this cleansing, purifying Kidney action, in just a day or so, may easily make you feel younger, stronger and better than in years. An iron clad guarantee insures an immediate refund of the full cost unless you are completely satisfied. You have everything to gain and nothing to lose under this positive money back guarantee so get **Cystex** from your druggist today for **only 35c.**

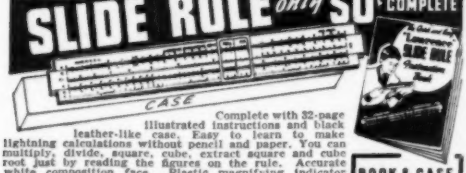
GET INTO AVIATION

Train Now at LINCOLN

Opportunities of a lifetime now open to men trained at this **LINCOLN GOVERNMENT APPROVED SCHOOL of AVIATION.** Our Graduates taking immediate employment in Airplane Factories, with Airlines, and at Airports at salaries up to $3600 a year to start. Draft age men also taking Lincoln Training to prepare themselves for enlistment in Army and Navy Air Services. You can train at this Lincoln School for positions as **Commercial Pilot, Flight Instructor, Aeronautical Engineer, Government Licensed Airplane & Engine Mechanic, Airplane Assembly Mechanic, Airplane Draftsman.** We train you and assist our Graduates in locating positions. New classes starting weekly. **WRITE TODAY for complete information.**

LINCOLN AERONAUTICAL INSTITUTE
6411 Aircraft Bldg., Lincoln, Nebraska

10" ACCURATE **SLIDE RULE** *only* 50¢ COMPLETE



Complete with 32-page illustrated instructions and black leather-like case. Easy to learn to make lightning calculations without pencil and paper. You can multiply, divide, square, cube, extract square and cube root just by reading the figures on the rule. Accurate white composition face. Plastic magnifying indicator makes numbers easy to read. Standard A, B, C, D, CI and K scales. 100% American made.

BOOK & CASE FREE of Extra Cost

RUSH ORDER TODAY—Send 50c in coin, stamps, or War Stamps. (Canada, 60c money order only.) Complete outfit mailed postpaid. Satisfaction guaranteed or money refunded. (Special quantity prices to schools and dealers.) Rush cash today for this great slide rule value.
FRANKLIN PRODUCTS CO., 260-L Maple Grove Ave., Ft. Wayne, Ind.

LAW

STUDY AT HOME for PERSONAL SUCCESS and LARGER EARNINGS. 31 years expert instruction—over 106,000 students enrolled. LL.B. Degree awarded. All texts furnished. Easy payments. Send for FREE BOOK—"Law and Executive Guidance".

AMERICAN EXTENSION SCHOOL OF LAW
Dept. 23-S, 8 East Huron St., Chicago, Ill.

WORLD'S LOST HORIZON

Your Part in Tomorrow's World

A New Age is dawning. A New Culture is being born. These changes are affecting you—now. Read "LEMURIA THE INCOMPARABLE." 60 pages of factual evidence supporting the existence of a New Race and Order. It is yours free. No obligation. Write today and learn how you can enter the new World of the Christed Children safely, joyously and triumphantly. There IS a haven of refuge for the pure in heart. Find it. Address Dept. Q.

LEMURIAN FELLOWSHIP
118 North Larchmont Blvd. Los Angeles, California

Learn **MECHANICAL DENTISTRY AT HOME!**

To make Crowns, Plates, Bridgework, etc., for Dentists. Easy practical way to learn mechanical dentistry at home in spare time. FULL EQUIPMENT OF TOOLS AND MATERIALS INCLUDED WITH COURSE. Low tuition. Easy terms. Write for FREE BOOK about this money making profession that is not affected by machine age.

McCARRIE SCHOOL OF MECHANICAL DENTISTRY
207 N. Broad St. Dept. 808 Philadelphia, Pa.

When Writing Advertisers
Please Mention POPULAR SCIENCE

BARREL O' FUN

32 Articles PLUS 12 Party Games!

Real fun-provoking articles—Daffy Diplomas, Nutty Novelties, Funny Favors, Goofy Gadgets, Belly-Laff Business Cards, Frizes and Surprises, Gags Galore—stunts that slay 'em.

Roll Out the Barrel at your next party

Send 50c and we'll send you BARREL O' FUN, postage prepaid. Or better still—send $1.00 and we will mail one to you, and one to a friend, whose name and address you will send us. (SURPRISE A SERVICE MAN WITH ONE). Your money refunded if you are not satisfied.
SKILCRAFT CO., Dept. 113, GENEVA, ILL.

HAVE THIS STAFF OF SPECIALISTS HELP YOU PATENT *your* IDEA

NO MATTER HOW GOOD your invention may be, the commercial value of your patent protecting that invention depends upon the careful preparation of strong claims covering it. This firm of Registered Patent Attorneys has helped and wisely advised individual inventors for almost half a century. Our staff is made up of specialists—men who are intimately familiar with those particular classes of inventions to which they devote their entire time. The object of this organization is to secure for its clients the strongest possible patents which their inventions warrant.

Present Defense Production

A GOLDEN OPPORTUNITY for Inventors

Don't forget—your patent will give you 17 years "exclusive right to make, use and sell". Inventions adopted now as substitutes for materials and equipment not obtainable will have become regular articles of our daily lives when this emergency is over. The time to act—to protect your idea for immediate and future commercialization—is NOW!

Send at once for these Books

FREE Here are two plainly written books which tell you, step by step, how to safeguard your invention—give you valuable ideas on commercializing your patent. With these two helpful books, we will send you also an all-important "Evidence of Invention" form. Don't delay. Get the coupon below into the mail AT ONCE!

VICTOR J. **EVANS & Co.**

Merlin M. Evans

REGISTERED PATENT ATTORNEYS
MAIN OFFICE: 640-M MERLIN BUILDING
WASHINGTON, D. C.

Please send me your books, "Patent Protection" and "How to Sell an Invention" without cost or obligation.

NAME.....

ADDRESS.....

CITY AND STATE.....

YOUR THEATRE

Today

Popular Science on-the-Screen

★

Featuring, in Full Color

Paramarines in Action!
Kitchen Magic
Bigger Cows-By Science

★

This announcement in front of your theatre is a genuine "sign" of good entertainment. Ask your theatre manager to book Popular Science on-the-Screen regularly . . . or write us . . . we'll ask him.

★

Please ask my theatre manager to book Popular Science on-the-Screen. 11-42

Theatre_____

Address_____

Mail to 353 Fourth Avenue
New York City, N. Y.

Produced in Magnacolor by Fairbanks and Carlisle with the cooperation of the editors of Popular Science Monthly. Distributed by Paramount Pictures.

2100 NEEDED INVENTIONS

THE secret of successful inventing is in **knowing what to invent!** That's why this remarkable new book by Raymond Yates, noted science editor and inventor, should be yours. It not only proves you don't have to be a genius to be an inventor. It shows how some of the simplest ideas like the paper clip and clamped fruit jar top made huge fortunes. Mr. Yates gets you started by describing 2100 needed inventions—practical money-making suggestions that are crying to be invented—each group neatly classified, such as Radio, Electrical, Aviation, Chemical. Also describes 10 most needed inventions—39 inventions U. S. needs most to win war. Order 2100 NEEDED INVENTIONS now and KNOW what manufacturers want before you waste time on impractical inventions! Special chapters included on Uncle Sam's call for wartime inventors. **Also shows how to develop and protect ideas! SEND NO MONEY.** On delivery pay postman $2.00, plus C.O.D. postage. Money back if not satisfied. Order today from **WILFRED FUNK, Inc., Dept. S, 354 Fourth Avenue, New York, N. Y.**

ANYONE CAN DO THIS IF THEY HAVE OUR CHART

SPECIAL OFFER FOR AGENTS

Blue Print 27" x 36" shows how to find length of any rafter, find any angle in degrees, frame any polygon 3 to 16 sides, read board foot and brace tables, octagon scale, rafter tables and many other uses. Can be scaled down for model work as well as full scale framing. Also chart changing pitches to degrees for use with Radial Saws. Send 50c coin. No stamps.

MASON & PARRISH ENGINEERS
2105-S N. Burdick St. Dept. A-2 Kalamazoo, Michigan

ATTENTION HIGH SCHOOL SENIORS!

Sell America's Most Beautiful and Distinctive **Graduation Name Cards!** Positively highest Commission. Lowest Prices. Representatives cards FREE! Limited supply of agencies. Send NOW for free sample kit to **PRINTCRAFT, 1423 E. Elm St., Scranton, Penna.**

YOU CAN HELP

SHOES, TIRES, RUBBER GOODS Last Longer. Fix them with new plastanoid 'putty.' MENDS holes and worn spots in leather, cloth, rubber. Spreads on like butter. Dries tough overnight. Flexible, non-skid, waterproof. Won't come off—guaranteed. 25 repairs—25 cents.

So-Lo MENDS THE HOLE

AT HARDWARE AND 10c STORES

Powerful Vision—8 Mile Range

BINOCULARS

20 Days Free Trial $4.75 Postpaid or C.O.D.

Scientifically ground, powerful lens that give sharp, clear vision of 110 yds. at 1000 yds. distance! Adjustable for all distances and eye widths. Binoculars come with handsome case and straps. GUARANTEED. If not satisfied after 20 days free trial money refunded.

American Binocular Co., 7759 S. Halsted, Dept. F-367, Chicago

---

Listen to this Record!

Learn to

SPEAK SPANISH

FRENCH, GERMAN, OR ITALIAN THIS EASY WAY

"Learn by listening" to Cortina records, the NATURAL way—quickly, easily, cheaply.

Sent on 5 Days' Approval

Most fascinating, most satisfactory method ever known for learning or perfecting yourself in a foreign language. **Investigate!**

Booklet FREE

"The Cortinaphone Short-Cut"—tells just what you want to know. Interesting. **Get it!**

Write Today--NOW

CORTINA ACADEMY (Language Specialists for 60 Yrs.)
Suite 1211, 105 W. 40th St., New York City

Please send me—without obligation—your free booklet. I an interested in (mark):

☐ SPANISH ☐ French ☐ Italian ☐ German

Name.....

Address.....

TRAVEL FOR "UNCLE SAM"

$1900 first year on regular Railway Postal Clerks

Many Other Government Jobs. Thousands appointments being made. Mail Coupon Today.

COUPON

Franklin Institute, Dept. R-250, Rochester, N.Y.

Sirs: Rush to me free (1) 32-page book describing many U. S. Government jobs. (2) Send particulars telling how to qualify for one.

Name.....

Address.....

INVENTORS—INDUSTRY NEEDS YOUR IDEAS NOW!

TWO REASONS: 1. Manufacturers are getting ready NOW for post war sales and production—

2. Right now, manufacturers are seeking products their expanded facilities can handle; factories must have products to take up the slack after war orders stop. Your chance comes with patent protection now—delay may endanger your chance. Get our NEW FREE Inventor's Book today and valuable "Invention Record" form. This request does not obligate you. *Act now. Write today.*

McMORROW & BERMAN
Registered Patent Attorneys Before U. S. Patent Office
1427 Barrister Building, Washington, D. C.

Send me your NEW FREE Book and specially prepared "Invention Record" form at once. I understand that this request does not obligate me.

Name.....

Street.....

City.....State.....

WRITE OR PRINT NAME CLEARLY

How to make a good living on a small farm

Want a small farm? Own one now? If you *do* want the enjoyment of security, a good living, pleasures of rural life, the freedom in being your own boss, FIVE ACRES AND INDEPENDENCE—the all-inclusive book by M. G. Kains, world's leading small farm expert—shows you how to select, how easily to run your farm successfully.

This book tells what kind of farm to rent or buy; how to choose it; finance it; what and how to plant; choice and care of livestock, poultry, bees, etc.; essentials of fruit and vegetable growing; fertilizers; irrigation; spraying; cultivation; harvesting; storage; sale of products and by-products. Every page packed with proved ways to make the small farm self-supporting—even profitable. Abundantly illustrated with workable plans and diagrams. Over 400 pages.

Plan *now* to get away from city worries, war shortages, high rents, inflation. Use this book as your guide. If not satisfied, return for full refund.

$2.50 FREE Examination

GREENBERG: PUBLISHER SN
404 Madison Ave., New York, N. Y.

Send me FIVE ACRES AND INDEPENDENCE at $2.50 postpaid. If not satisfied, I may return it within 7 days for full refund.

☐ Payment enclosed ☐ Send C. O. D.

NAME.....

ADDRESS.....

CITY & STATE.....

INVENTORS
PATENT YOUR IDEAS
SEND FOR FREE BOOK →

HOW TO OBTAIN A PATENT

Written by a Former Member of the Examining Corps (1922-34) of the U. S. Patent Office. If you want to profit by your idea, you should take steps to apply for a U. S. Patent at once. Your first step is to get this Free Book. This interesting illustrated book contains valuable information you should have. It tells you fully how to obtain a patent on your idea in the quickest way. With this Free Book you will also receive a "Record of Invention" form on which you can easily record your idea. Personal and Confidential Service: Your case will be personally handled only by a Registered Patent Attorney who is also a Former Member of the Examining Corps of the U. S. Patent Office. All communications confidential.

MAIL COUPON TODAY for FREE PATENT BOOK and RECORD OF INVENTION Form.

CARL MILLER
REGISTERED PATENT ATTORNEY
FORMER MEMBER EXAMINING CORPS U. S. PATENT OFFICE

Woolworth Bldg., 35th Floor, Dept. 112C, New York City
BOND BUILDING, Dept. 112C, WASHINGTON, D. C.
Please send me your Free Book, "How to Obtain a Patent," and your "Record of Invention" form.

NAME.....

ADDRESS.....

Learn Profitable Profession in 90 days at Home

Earnings of Men and Women in the fascinating profession of Swedish Massage run as high as $40 to $70 per week but many prefer to open their own offices. Large incomes from Doctors, hospitals, sanitariums and private patients come to those who qualify through our training. The Army and Navy need hundreds trained in massage. Write for Anatomy Charts and booklet—They're FREE.

THE COLLEGE OF SWEDISH MASSAGE
30 E. Adams St., Dept. 870, Chicago

THE KNIFE THAT MAKES THOSE

NAVY plane MODELS

QUICKER, EASIER,
At your dealer's or direct.
Sets $1 to $3.50. Extra blades
50c for pkt. of 5-

X-ACTO CRESCENT PROD. CO., INC. Dept. PS 440-4th Ave. New York City

50c each

X-acto

Refill-blade KNIFE

Send 10c for booklet "HOW TO MAKE SCALE MODELS FOR DEFENSE"

INVENTIONS WANTED

Useful new ideas are urgently needed to meet the rapidly changing conditions of warfare and commerce. If you have a useful invention for sale it can now be safely marketed without patenting expense! Write for complete details, today.

Chartered Institute of American Inventors
Dept. 3, Barrister Building, Washington, D. C.

PATENTS
PERSONAL SERVICE

My *Personal* service assures strictest confidence on all your patent problems. Send me a model or drawing, or sketch and description of your invention, and $5.00. I will make a search and report promptly as to its patentability and send you a copy of my 72-page booklet. Or, if you prefer to read my booklet first, write today for *FREE* copy. Registered Patent Attorney.

L. F. Randolph, 340-D Columbian Bldg., Washington, D.C.

PATENTS
AND TRADE MARKS
C. A. SNOW & CO.

Registered Patent Attorneys Since 1875

Write for Free Book and "Certification of Invention" form

427 SNOW BUILDING, WASHINGTON, D. C.

8 Mile Range-Wide Vision

BINOCULARS $4.75

15 Days FREE TRIAL
Postpaid or C. O. D.

Comes complete with case and straps. Well ground powerful lens. Easily focused for all distance and eye widths. Latest features. Ideal all-weather binoculars. **Guaranteed.** If not satisfied after **15 days trial**, money refunded. AGENTS WANTED.

Vogue Binocular Co., 7759 S. Halsted, Dept. 844, Chicago

AIRCRAFT CONSTRUCTION
STUDY AT HOME

QUICKLY AND EASILY SELF-TAUGHT
NO HIGH SCHOOL EDUCATION NECESSARY
MEN AND WOMEN—MAKE BIG MONEY

Industry is Clamoring for Help
Complete Course—Thoroughly Illustrated
ONLY $10
HOME STUDY INSTITUTE, 236 W. 55th (Dept. A-21) N. Y. C.

"MY JOB'S IMPORTANT! IS YOURS?
AIRCRAFT INSTRUMENT MEN NEEDED AT ONCE!"

PREPARE in AVIATION'S *MOST VITAL BRANCH*

AIRCRAFT INSTRUMENTS

HOME STUDY—LEARN BY DOING!

Practical, complete training—on actual instruments furnished by the school—qualifies you for well-paying positions with manufacturers, airlines and instrument service and repair stations.

Send for CATALOG today . . .

EASTERN AIRCRAFT INSTRUMENT SCHOOL

"Largest in the East"

DEPT. SR 116 NEWARK AVENUE JERSEY CITY, N. J.

Your CAREER in Plastics

Free Booklet on **PLASTICS**

A great one-time industry, Plastics offers tremendously increasing possibilities in post war developments already under way. Virtually every industry is using, or planning to use Plastics. This booklet outlines the opportunities existing in this rapidly expanding industry, gives a history of plastics materials, and indicates educational background necessary and employment possibilities in chemical engineering, molding, fabricating, and other divisions of Plastics.

Plastics Industries Technical Institute

1220-D Chanin Bldg. NEW YORK CITY — 626-D LaSalle-Wacker Bldg. CHICAGO, ILLINOIS — 1945 Alvarado St. LOS ANGELES, CALIF.

BUILD ARC WELDER FROM OLD GENERATOR

For Light or Heavy Work. 30-200 amperes. Complete **PLANS** 35c. Send today and we'll include **FREE** our 1942 Catalog.

LEJAY Mfg. Co., 1323 Lejay Bldg., Minneapolis, Minn.

RHEUMATISM

ARTHRITIS - NEURITIS - SCIATICA

Why continue to suffer the agonizing pains of these diseases when the usual remedies have failed? Learn about a new trustworthy, modern, non-surgical treatment method. This marvelous treatment is completely explained in the Ball Clinic's **FREE** Book. Write today. No obligation.

BALL CLINIC, Dept. 5100, Excelsior Springs, Mo.

Learn CARTOONING

FREE TRIAL LESSON! Cash in on your sense of humor—AT HOME—BY MAIL. Have fun! Make money! No experience needed to start. Write today for FREE LESSON, mailed postpaid. No obligation.

Moon Gag-Cartoon School, Dept. 100, Fall Creek, Wis.

BOOKS THOUSANDS OF BARGAINS LOW AS **5¢** each

Send postcard for free Little Blue Book catalogue. Thousands of bargains. **HALDEMAN-JULIUS CO., Desk M-986, GIRARD, KANSAS.**

MEN MADE TO ORDER

Fit Your Abilities To The Opportunities

You have unused talents and mental powers. Learn to develop those faculties of mind which today's world of *business demands*. Start life anew—*without changing your affairs*. Write the *Rosicrucians* for *free* Sealed Book telling how you may receive age-old teachings to *achieve* personal power.

Address: Scribe L.U.O.

The **ROSICRUCIANS, (Amorc) • San Jose, Calif.**

DRAKE'S AIRCRAFT POWERPLANT MANUAL

Just Printed

LATEST DATA ON ALL IN-USE POWERPLANTS

Get in the Big Pay

SEND NO MONEY

Get this manual! Simple, understandably written for beginner or expert by G. Burnell Manly of Allison Motors. Tells how to tear down, overhaul, reassemble all modern aircraft engines, superchargers, fuel injectors, timing, ignition systems, variable pitch propellers, etc. Everything brand new, up-to-the-minute. Nothing like it.

300 ILLUSTRATIONS, 760 PAGES

used as text by Commercial, Military and defense schools. Everything you'll want and need to know about aircraft power plants. Get it NOW. NO OBLIGATION unless completely satisfied. You don't risk a cent.

FREDERICK J. DRAKE & CO., 600 W. VAN BUREN, CHICAGO

FREE 5 DAY EXAMINATION

$4 COMPLETE SENT POSTPAID

FREDERICK J. DRAKE & CO., Dept. PS-11, 600 W. Van Buren St., Chicago

( ) I am enclosing $4.00. Please rush my copy of AIRCRAFT POWER PLANT MANUAL. Postpaid.

( ) Please send C.O.D. I will pay postman $4.00 plus a few cents postage.

In either case if I am not entirely satisfied and return this book within five days, you will refund my money in full.

NAME.....

ADDRESS.....

CITY..... STATE.....

☐ **Please include catalog on complete line of technical books.**

NEWEST BOOK ON

AIRCRAFT SHEET METAL CONSTRUCTION *and* REPAIRS

ONLY $1.50

TELLS BASIC OPERATIONS ACTUAL CONSTRUCTION METHODS—SIMPLE CONCISE, UNDERSTANDABLE FOR EXPERIENCED OR BEGINNING SHEET METAL WORKERS

Shows and explains aircraft WELDING, SOLDERING, BENDING, CUTTING, FORMING, wing and fuselage construction and repair. A complete—19 chapter—profusely illustrated HOW-TO-DO-IT book covering all phases of aircraft sheetmetal work. Tables bearing on strengths of aluminum alloys—gages, analysis and descriptions of metals used in aircraft construction—How to repair and maintain aircraft plumbing, cooling and oiling systems, tanks, floats, etc. Contains every item of information the aircraft sheetmetal worker should know. Cloth bound. It's all new, JUST PUBLISHED. Order yours now.

FREE **FREDERICK J. DRAKE & CO. 600 VAN BUREN, CHICAGO**

5 DAY EXAMINATION

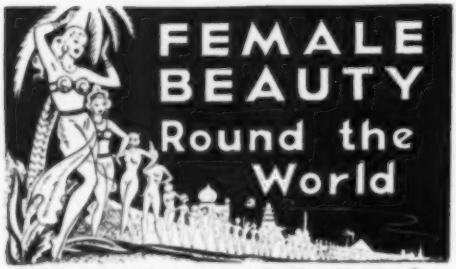
FREDERICK J DRAKE & CO., Dept. PS-11, 600 W. Van Buren St., Chicago

SEND DRAKE'S AIRCRAFT SHEETMETAL CONSTRUCTION AND REPAIRS Postpaid. ☐ I ENCLOSE $1.50. ☐ SEND C.O.D. I WILL PAY POSTMAN $1.50 (plus small shipping charges). In either case I may return the book within 5 days for any reason whatsoever and my money will be refunded in full.

NAME.....

ADDRESS.....

CITY..... STATE.....



World's Greatest Collection of Strange & Secret Photographs

NOW you can travel round the world with the most daring adventurers. You can see with your own eyes, the weirdest peoples on earth. You witness the strangest customs of the red, white, brown, black and yellow races. You attend their startling rites, their mysterious practices. They are all assembled for you in these five great volumes of The **SECRET MUSEUM OF MANKIND.**

600 LARGE PAGES

Here is the world's Greatest Collection of Strange and Secret Photographs. Here are Exotic Photos from Europe. Primitive Photos from Africa. Torture Photos from Asia. Strange Photos from Oceania and America, and hundreds of others. There are almost 600 **LARGE PAGES of Strange & Secret Photographs,** each page 57 square inches in size.

1,000 STRIKING PHOTOS
A BOOK ON TRAVEL AND EDUCATION

You see actual courtship practiced in every quarter of the world. You see magic and mystery in queer lands where the foot of a white man has rarely trod. You see Oriental modes of marriage and slavery in China, Japan, India, etc. Through the intimacy of the cameras you witness the exotic habits of every continent and the strangest customs, in America, Europe, etc. You are bewildered by these large pages of **ONE THOUSAND PHOTOGRAPHS,** including 130 full-page photos, and thrilled by the hundreds of short stories that describe them.

Contents of 5-Volume Set

VOLUME 1
The Secret Album of Africa
VOLUME 2
The Secret Album of Europe
VOLUME 3
The Secret Album of Asia
VOLUME 4
The Secret Album of America
VOLUME 5
The Secret Album of Oceania

5 PICTURE-PACKED VOLUMES

Specimen Photos

Dress & Undress Round the World
Various Secret Societies
Strange Crimes, Criminals
Omens, Totems & Taboos
Mysterious Customs

1,000 Strange & Secret Photos

The **SECRET MUSEUM OF MANKIND** consists of five picture-packed volumes (solidly bound together for convenient reading). Dip into any one of these volumes, and as you turn its pages, you find it difficult to tear yourself away. Here in story and unusual photo is the **WORLD'S GREATEST COLLECTION OF STRANGE AND SECRET PHOTOGRAPHS,** containing everything from Female Beauty Round the World to the most Mysterious Cults and Customs. These hundreds and hundreds of large pages will give you days and nights of thrilling instruction.

SEND NO MONEY

Simply sign & mail the coupon. Remember, each of the 5 Volumes is 9¼ inches high, and, opened, over a foot wide! Remember also that this 5-Volume Set formerly sold for $10. And it is bound in expensive "life-time" cloth. Don't put this off. Fill out the coupon, drop it in the next mail, and receive this huge work at once.

METRO PUBLICATIONS, 50 West 17th St., Dept. 711, New York

Send me "The Secret Museum of Mankind" (5 great volumes bound together). I will pay postman $1.98, plus postage on arrival. If not delighted, I will return book in 5 days for full refund of $1.98.

Name .....

Address .....

City ..... State .....

☐ CHECK HERE if you are enclosing $1.98, thus saving mailing costs. Same Money-Back Guarantee.
Canadian Orders—$2.50 in Advance.

RIDE ON PUNCTURED TIRES

TUBE WITH 50 NAIL HOLES STAYS INFLATED

Car and Truck owners, attention! Here's news of a discovery that should add countless miles to your tires. Anyone can quickly and easily insert the Tyr-Saver into inner tubes and, presto, they become puncture-proof as tho you paid from $6 to $10 to have the job done for you. Yet **TYR-SAVER** costs only $1.49 for four tires. No equipment necessary. In actual test 50 nails were driven into a tire in which the tube was treated with **TYR-SAVER** and the tire remained inflated. With tires becoming more precious every day, you should protect yours and make them last as long as possible. So write now. Send your name and address for a supply of **TYR-SAVER** sufficient for four tires. On arrival just pay your postman $1.49 plus postage. You must be satisfied or your money will be refunded anytime within 30 days. Order today.

TYR-SAVER
2227-A Calumet Ave. Chicago, Ill.

SHORT WARTIME COURSES

UNCLE SAM NEEDS YOUR HELP in war industries and armed forces. A million technically trained men wanted—**Electro-Technicians, Aviation Mechanics, Aircraft and Arc Welders, Draftsmen, Radio Men.** Prepare now for bigger and better job opportunities in vital industries. Earn while you learn. Write for FREE illustrated book on Short Wartime Courses. Mention course desired.

MILWAUKEE SCHOOL OF ENGINEERING
PS-1142 N. Broadway & E. State, Milwaukee, Wis.

TRAILER BUILDERS' PARTS CATALOG

We'll save you money on everything. Largest and most complete trailer builders' supply house in the United States. Member TRAILER COACH MFRS'. ASSOC. Send 10c for parts catalog.

Complete Plans and Building Instructions 25c

NATIONAL TRAILER EQUIPMENT CO.
719 N. Seventh St. Milwaukee, Wis.

How to Improve Your Woodworking!

Here is a new manual written especially for the man who likes to make things in his own workshop! Tells you how to make shoulder cuts, taper cuts, convex and concave cuts, how to bore and mortise by machine, how to apply fillers, stains, finishes—everything you need to know to turn out articles that are *really* professional! Complete with working diagrams and step by step instructions, including 236 valuable illustrations! 192 pages. Attractive cloth binding.

SEND NO MONEY NOW!

Just mail coupon below for your copy of WOODWORKER'S TURNING AND JOINING MANUAL. Pay postman $1.00 plus few extra cents postage on delivery. If you prefer to remit now, we pay postage. Money back if not satisfied.

Popular Science, Dept. 112A
353 Fourth Avenue, New York, N. Y.

Please send me your new WOODWORKER'S TURNING AND JOINING MANUAL. I will pay postman only $1.00, plus few cents postage on delivery. I understand that I may return the book within 10 days for full refund if not completely satisfied.

Name .....

Address .....

City ..... State .....

Orders from outside the U.S. must be accompanied by cash.

YOU
CAN SUCCEED IN AVIATION

STUDY AT HOME and win out in the fight for future security by becoming a well-informed expert in the field of aircraft construction and maintenance.

Full information and costs of the practical, up-to-the-minute Ryan Home Study training will be sent without obligation. Mail this ad and begin your spare time study.

RYAN AERONAUTICAL INSTITUTE
4111 Lindbergh Field, San Diego, Cal.

Learn PLASTICS

Get into Plastics! Your big opportunity. Enter a New Industry. Plastics is thrilling, profitable, uncrowded. Learn Now! *First Plastics School in the East with complete Study and Lab. courses.* Write Dept. P Today! State age.

BOSTON TECHNICAL INSTITUTE
SCHOOL of PLASTICS
420 COMMONWEALTH AVE. BOSTON, MASS.

STUDENTS A Slide Rule For Only 50c. A, B, C1, C, D & K Scales. All American made. Multiplies, divides, solves square and cube root problems instantly. 32-page Instruction Book included free. Rush 50c today. War stamps accepted. (60c money order only from Canada.)

FRANKLIN PRODUCTS CO.
260-LC Maple Grove Ave. Fort Wayne, Ind.

LEARN MONEY-MAKING CARTOONING

Same simplified method that has helped train creators of "Terry & Pirates," "Wash Tubbs," "Out Our Way," "Winnie Winkle," "Reg'lar Fellers," "Strange As It Seems," "Secret Agent X-9," and many others. Earn while learning. Rush 10c for Picture Chart (to test your ability,) and full details. (State age).

THE LANDON SCHOOL, 4231 National Building, Cleveland, Ohio

SUPER JU JITSU

NOW—YOU CAN *Destroy Your Enemy Quick!*

WHEN THIS HAPPENS TO YOU···

DO THIS

BE A ONE-MAN BLITZ! Strike with Commando lightning! You don't need ox-like muscles to use Super Ju Jitsu, most powerful of all defense and attack methods. **Technique** is the deadly secret. Brains count—not size, not strength. Almost miraculously efficient.

Gain Self-Confidence

KNOW how YOU can lick brutes twice your size with your bare hands only, even when they are ARMED with gun, knife, club. Get ready now for any emergency—protect your loved ones. Amazing self-study course teaches you double-quick. No boring exercises needed.

OR DO THIS

Send for Exciting Details—Free!

FREE Startling Low Price. **Satisfaction Guaranteed** or your money back. Mail coupon now.

NELSON CO., 500 Sherman Street
DEPT. L-503, CHICAGO, ILL.

Please rush me free the hard-hitting details about "Super Ju Jitsu." No obligation on my part.

NAME_____

ADDRESS_____

SPRAYBERRY RADIO TRAINING
includes
FULL EQUIPMENT
Experience Easily Acquired at Home

You Do Practice-Giving Experiments, Many Special Features . . . ALL Designed to Help You Make Fast Progress.

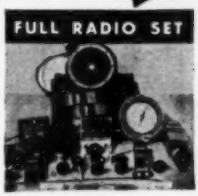
SPRAYBERRY Training starts right at the beginning of Radio . . . unfolds each subject in a simplified, logical, understandable style. You easily learn Television, Frequency Modulation, Signal Tracing, Mobile Radio (Auto-Tank), Aviation Radio, Electronics, Facsimile Radio, Radio Set Repair and Installation work.

Training Prepares You for a Business of Your Own . . . or Good Radio Jobs —Civilian or Military

The important and fascinating field of Radio offers many opportunities to the man who wants to get ahead. My Training is designed to give you quick access to these opportunities. SPRAYBERRY Methods are thorough and practical. Your Training will not interfere with your present duties. No previous experience is needed.

You Get a Dual-Purpose Radio Set

I supply you with Radio Parts which you use to gain pre-experience in Repair work. These same Parts are used as a Modern Signal Generator and for Signal Tracing, etc. You'll find my Course and Equipment fully described in the catalog offered below. But in addition to this catalog, I am going to send you, without obligation, a valuable new manual,



YOURS FREE! Just Off the Press
BIG 80-Page Book
"RADIO SERVICE SHORT CUTS"

Don't miss it! It's a rich storehouse of practical tips and information. In keeping with the same plain, to-the-point language found throughout the Sprayberry Course, this handy volume tells how Radio break-downs occur . . . how to spot these defects . . . how to correct them quickly and efficiently. There is no fluff or ornamentation . . . simply the practical answers to the problems you meet as a busy, successful Radio man. If you act now, you can get this book FREE . . . along with my descriptive Course Catalog. Use coupon below!

THE SPRAYBERRY COURSE IS SOLD UNDER MONEY-BACK AGREEMENT

RUSH COUPON for BOTH FREE BOOKS

SPRAYBERRY ACADEMY OF RADIO
F. L. Sprayberry, President
555-L University Place, N. W.
Washington, D. C.

Please rush my FREE copies of "HOW TO MAKE MONEY IN RADIO" and valuable 80-page "RADIO SERVICE SHORT CUTS".

Name.....

Address.....

City.....State.....

(Mail in envelope or paste on penny postcard)

Please mention POPULAR SCIENCE *when writing to advertisers.*

POPULAR SCIENCE *Classified* OPPORTUNITIES

MONEY-MAKING, MONEY-SAVING

Classified Ads only 35c per word per insertion, payable in advance. Minimum ad 10 words. To be included in December issue copy should be in our office by October 9th. December issue on sale October 30th.
POPULAR SCIENCE MONTHLY—351 FOURTH AVE.—NEW YORK CITY

ADVERTISING

FREE—"10 Reasons" why you'll profit by classified advertising in Popular Science. Write for this free folder today. Read the important facts it contains before you place any classified advertising. Write for your copy today—it's free! O. K. Kelly, Room 1100, 353 Fourth Avenue, N. Y. C.

MAIL-Order or agent ad reaching 1,000,000 families throughout United States $14.00 inch. Newspaper, magazine, mailing-list, ratebook, free. Chicago Advertising Agency, 20-SP West Jackson, Chicago.

ADVERTISE: 24 words, 149 newspapers, $6.50. Lists Free. Advertising Bureau, 4515-P Cottage Grove, Chicago.

SALES Letters That Sell! Get more business by mail. S. Hahn, P-233 East 32nd St., New York City.

24 WORDS 35 newspapers $2.00. Goodall, 37 Gardner, Vallejo, California.

ADVICE

ADVICE—Personal, 35c; Business, $1.00. "Confidential", 9 Dana, Lynn, Mass.

AGENTS WANTED

MAKE Easy Money Selling Foremost Line Christmas cards. "Leader" assortment-21 gorgeous folders going like "Wildfire." Sells for $1.00, costs as low as 50c. Actual retail value $3.00. Other Bargain assortments. Also, 50 Christmas cards imprinted with name for $1.00. Finest low-priced imprints in America. Write for sample "Leader" assortment On Approval, also two portfolios imprint cards and Free Gift offers. Silver Swan Studios, Inc., 320 Fifth Avenue, Dept. 55, New York.

SELL Christmas Card sensation! New "Prize" 21-card assortment leads in value, appeal. Sells $1—pays up to 50c. 11 fast-selling assortments. Christmas Cards with name 50 for $1, up. Samples on approval. Chilton Greetings, 147 Essex, Dept. 41-T, Boston, Mass.

AMBITIOUS School Seniors—Sell Classmates the "tops" in Graduation Name Cards. Best Commissions. Free Cards. Agencies going like wildfire. Hurry! Craftcards, Box 235-M, Pittsburgh, Pa.

FAST selling rubber drug store item. Every man a good prospect. 200% profit. Illustrated price list free. Complete sample assortment $1.00. Hygienic Drug Products, Dept. 103, Box 2353 Merchandise Mart, Chicago.

LORD'S Prayer, Ten Commandments, or Crucifixion, engraved on real pennies. Individually carded. Fastest 10c sellers in years. $5.25 gross. Trial order, generous assortment, sent prepaid $1.00. Perkins, 4745 Broadway, S-11, Chicago.

FREE literature on new Line Phonograph Scratch Filter and Tone Equilizer, also on Radio wavetrap and signalbooster. Send $2 for both samples and make profits immediately. Goldshield Products, Dept. S, 350 Greenwich St., New York.

MEXICAN bird pictures hand made with real feathers. Free particulars. Sample 10c. Importer C. Staff, 14960 Evanston, Detroit, Michigan.

POWERFUL Mile Stretcher. More miles—power. Reduces costs. Guaranteed. Free offer. Thermoxd, Peoria, Ill.

$1 STARTS you in business selling men's ties, ready tied Slyde-On-Ties and boxed novelties. Write today for descriptive wholesale catalog, free sample materials. Philip's Neckwear, 20 West 22nd St., Dept. M21, New York.

MEN and Women Wanted! Full or part time. We help you get started on Rawleigh Route of 800 families. Large sales mean big profits. Write Rawleigh's, Dept. K-180-PSC, Freeport, Ill.

SELL new-used clothing from home, auto, store. Men's suits $2c, leather jackets 45c, overcoats 51c, dresses 9c, ladies' coats 33c. Other bargains. Catalog free. S&N, 565A Roosevelt, Chicago.

GOOD Paying business silvering mirrors, plating autoparts, reflectors, bicycles, bathroom fixtures by late method. Free particulars and proofs. Gunmetal Co., Ave. G, Decatur, Ill.

MEXICAN Feather, Straw, Pictures; sandals, tablecloths, etc. Quick sellers! 100% —300% profit! Free particulars. Samples 10c stamps. Marquez-1E, Apartado 1176, Mexico City.

BIG Money taking orders; Shirts, Ties, Hosiery, Underwear, Pants, Jackets, Sweaters, Uniforms, etc. Sales equipment Free. Experience unnecessary. Nimrod, 4922-AV Lincoln, Chicago.

SCHOOL Seniors—Sell graduation name cards. America's largest, fastest-selling, low-priced display, 35% commission. Free cards. Universal Engraving & Printing, Box 745-P8, Pittsburgh, Pa.

BIG clothing bargains for big profits. Used dresses 10c, men's suits $1.00, shoes 12½c. Over 100 sensational values. Experience unnecessary. Free Wholesale Catalog. Superior, 1250-CE, Jefferson, Chicago.

"CAR Watchman" prevents thieves from stealing tires, gas, equipment. Amazing invention. Whirlwind seller. Big profits. Write quick. Northwest Electric Co., N-14, Pukwana, S. D.

MAN, You'll Like Silvering Mirrors! Making chipped glass nameplates, signs, markers, mottos. Outfit prices. Sprinkle, Plater, P91, Marion, Indiana.

FREE Water and our concentrates, makes flavors, lotions, shampoos, 73 products, labels, bottles furnished. Qualco, F-20030 Russell, Detroit.

MAGIC Shopping Bag. Sells like wild. Magically turns purse into roomy shopping bag. Handy, compact. Samples sent on trial. Kristee 122, Akron, Ohio.

MAKE money applying initials on automobiles. Also, sideline salesmen for short run Decal name plates. Ralco, 727 Atlantic, Boston, Mass.

MEN'S shoes 14c, hats 12c, pants 28c, dresses 10c, winter coats 50c, fall coats 35c. Bargain catalog Free. Portnoy, 566-W Roosevelt, Chicago.

SEND for Free copy of Illustrated Wholesale Christmas Catalog! Forty profitable lines! Elfco, 438 North Wells, Chicago.

AGENTS—300% Profit selling Gold Leaf Letters; stores and offices. Free samples. Metallic Letter Co., 437 N. Clark, Chicago.

SELL Latex Products. Large Profits. Send $1.00 for samples. Peerless, 4050 BP Broadway, Kansas City, Mo.

HITLER'S Will, sealed envelope. Sample, 10c. Vogl, 109 Broad St., N. Y. C.

ANTIQUES, RELICS INDIAN GOODS

25 GENUINE Indian Arrowheads, $1.00. Catalog, Geo. Holder, Glenwood, Ark.

AUTHORS SERVICE

NEW Writers Wanted to re-write ideas in papers, magazines, books. Splendid opportunity to "break into" profitable writing field. Rush postcard for Free Details. Comfort Writer's Service, Dept. FW-150, St. Louis, Mo.

AUTOMOBILES

AUTOMOBILE Racing Book, Fifth Edition —Revised. Tells how to build dirt track bodies, frames, engines, Records, superchargers, rules, formula, plans, stock conversions, roadster racing, fast Fords. $1.00 postpaid: $1.15 C.O.D. Ray Kuns, Department 274, Madisonville, Cincinnati, Ohio.

WHIRLGAS Superchargers, $3, increase mileage 20%; power 10%. Refund guarantee. University test. Any car; give make, year. Wrench installs 15 minutes. Good results with 30% fuel oil mix. John Hanley, Manufacturer, 5719 Loraine, Detroit, Mich.

PHOTOGRAPHS—World's finest automobiles. List Free. Automobiles, Box 534, Saint Cloud, Minnesota.

AUTO SUPPLIES & EQUIPMENT

TIRE Care and maintenance, new book just out, tells how to retread your own tires, make rubber cement, reclaim scrap rubber for 1c per pound, run your car on kerosene, 12 tire maintenance trade secrets disclosed, $1.00 postpaid, money back guarantee, air mail delivery. The Harris Co., Boaz, Wisconsin.

CONVERT your car to burn Diesel oil. Save up to 70% fuel costs. Cheap installation. Wonderful performance. Proven factory method. Different and better. Costs nothing to investigate. Write for free circular No. 3. Harrington Company, 201-204 Manchester Bldg., Portland, Oregon.

GAS Rationing! Burn kerosene or other cheap fuel. Convert your car with used and discarded parts. Simple guaranteed instructions, $1.00. Wayne Engineering, Box 18, Greenville, Ohio.

KEEP her rolling! Gasless gas, puncture preventative, vulcanizing cement, 9 other wartime maintenance secrets. Rush $1.00 (Money back guarantee). Autosaver, Dept. L-127, Cincinnati.

SAFEGUARD your tires. Keep tires properly inflated with new safety valve cap. 5 caps, $1.00 prepaid. Welchtman, Ball-Farm, Oakville, Conn.

FUEL oil conversions—For automotive, marine engines. Write for free literature. Houston & Logan, 2112 Addison, Berkeley, California

RUBBER preservative—doubles, triples life; formula, 25c. Victory Sales, Box 5172, Chicago, Illinois.

RUN any car on kerosene! Diagram, simple instructions, rush $1.00—postpaid. Car Savers, 13 Sta. M, Cincinnati, Ohio.

REFINE used oil without cost. Particulars —C. Gerwin, Alva, Okla.

AVIATION

AVIATION Cadet Preparatory Course. Homestudy, $25. Successful instruction assured. Captain A. T. Bell, Merrick, N. Y.

HUNDREDS of airplanes grounded on coasts and small airports. Send 25c for new Directory of War-Bargains. Super Heath Parasol, complete less motor, $35. Motors $20 up. Used Aircraft Directory, Athens, Ohio.

BUILD and fly your own motorcycle powered monoplane, home. Easy, cheap. Tested plans, guaranteed, $1.00. Aerotech, Dearborn, Mich.

AVIATION Cadet examination preparation by home study course. Rutherford Preparatory School, Long Beach, Calif.

JOIN U. S. Rocket Society! Information dime. 417 Main St., Glen Ellyn, Ill.

BATTERIES, GENERATORS, ETC.

EDISON lifetime storage batteries for light and power. Eliminate acid battery diseases. Long guarantee. All kinds rebuilt generating plants, motors, and miscellaneous articles at bargain prices. Free interesting literature. W. Hawley Smith Company, Croton Falls, N. Y.

NEW inexpensive method puts failed batteries back into car, truck and farm-lite service. No magic fluid. No lead burning. Complete instructions, $1.00. Popular Service, Dept. C, Racine, Wisconsin.

BOATS, OUTBOARD MOTORS, ETC.

REBUILT outboard motors. Fully guaranteed. Over 300 to pick from. Send 10c for complete list. Boat Design Book 15c. Buy now before prices advance. Chicago's largest dealer. Masters & Son. 216 West Chicago Ave., Chicago.

FULL size, cut to shape boat patterns, blueprints. 7½ — 3C feet. Illustrated "Build a Boat" catalog, 10c (coin). "How to Build Boats" book, $1.00. Cleveland Boat Blueprint Co., Station A-77, Cleveland, Ohio.

OUTBOARD Motors, Used and Rebuilts. Save money. Used parts. Bargain list free. Crandall-Hicks, 955 Commonwealth, Boston, Mass.

FORD Marine Conversions. Catalog 10c. Lehman Engineering Co., Dept. A, Newark, N. J.

BODY-BUILDING COURSES

SUPER Ju-Jitsu—lightning defense and attack system. Sensational new home study course now ready! Learn to lick brutes twice your size with only your bare hands. Free details. Ju-Jen Co., 500 Sherman, Dept. L-509, Chicago.

BAR-BELLS, Dumbbells, Exercise equipment, Courses, Special offers! Free booklet. Good Barbell Co., 3261-PS Watson Rd., St. Louis, Mo.

HANDBALANCING builds muscles. Easily learned. Power. 923 W. Vine, Kalamazoo, Mich.

BARBELLS all new seven dollars per 100 pounds. Detroit Michigan Barbells, 5740 Woodrow.

BOOKS, PERIODICALS

BUSINESS, trade and diversion magazines. Current copies. 438 different publications, representing 122 vocations to choose from —mechanical, electrical, building, plumbing, live stock, poultry, printing, journalism, photography, advertising, music, hobbies, stamp collecting, patents, mail order, radio, aviation, sports, etc. Free price list. Commercial Engraving Publishing Co., 348 North Ritter, Indianapolis, Indiana.

IDEAS for sale—cheap! Authentic information precision lens grinding, glassblowing, high vacuum technique, high temperature apparatus—in fact, almost any procedure in physics is completely described and illustrated in "Procedures in Experimental Physics," by John Strong, California Institute of Technology. $6.70 list. Prentice-Hall, Inc., 70 Fifth Avenue, New York City.

SAVE up to 50% on home repairs! Big new book, "Tinkering With Tools" shows how to do hundreds of odd jobs around the house. Fully illustrated. Only $1.00! Dept. C-112, Popular Science, 353 Fourth Ave., New York City.

EDUCATIONAL Books sold cheaply or rented for small fee. Books bought. Money back guarantee. 4,000 Bargains. Catalog Free. (Courses Bought). Lee Mountain, Pisgah, Ala.

"HOW To Draw From Nude Models". Gorgeous art photo-tone poses. Complete instructions, $1.00. Sample lesson, 25c. Money-back guarantee. Ray Rogers, 869 Boro Hall Building, Brooklyn, New York.

ANY Book, (New, Used, Out-of-Print, Rare). Promptly Supplied! Lowest Prices! Send for Free Bargain Catalogues! Old Prof's Book Shop, S16, Arcadia Court, Pontiac, Mich.

GENERAL Douglas MacArthur, Fighter for Freedom. New authentic life-story. Illustrated circular. B120, Arkansaw, Wisconsin.

EXCELLENT sparetime profits taking subscriptions—2500 magazines. Complete Starting supplies Free! Pines, 583 Monroe, Brooklyn, N. Y.

REBINDING: Have your old books, Bibles, Hymnals rebound. We bind magazines. Write for prices. The Heckman Bindery, Dept. I—North Manchester, Indiana.

200 MAGAZINES Free. 15 or more each month. Many carry no advertising—all meat. Timely—informative. Busch Press, S-2405 South Karlov, Chicago.

LOVE Diary—(Ruthbella-Sansicchi). Privately printed, deluxe. Price $5.00. Sample, 25c. Ferrante Art Press, 309 Third, Palisades Park, N. J.

ADVERTISERS!

Increase Your Mail Order Business!

Good advertising values are in keeping with the times.

Popular Science Monthly's CLASSIFIED SECTION now offers the biggest value in its history. Year after year our circulation has steadily increased. Today it is the largest it has ever been! Our latest A. B. C. report shows an average monthly circulation of

731,158

This is a substantial increase in the number of prospects for classified advertisers—and at no increase in advertising cost. Our classified rate is still only 35c a word for the largest circulation in the entire science-mechanics magazine field!

Take advantage of this extra advertising value by offering your product or service to this great audience of Popular Science readers. Prepare your advertisement now! Count the number of words and remit at the rate of only 35c a word. Act promptly to be sure of publication of your advertisement in the next issue.

Classified Section

POPULAR SCIENCE MONTHLY

353 Fourth Ave., New York City

SENSATIONAL, Thrilling! Mexican-Cuban, art pictures, books, miscellaneous. Samples, lists, 50c. Jordan, 135-L Brighton St., Boston.

GAY Cartoon Booklets (Stag Party Series), Art Photos, Novelties, Books. Big assortment $1.00. List 10c. Gross Specialties, P. Carnegie, Pa.

RECEIVE $3.00 Best-seller, monthly selection, books, for 75c on approval without obligation. Kassin, 396 Broadway, New York.

PHOTOS, cartoons, pictures, cards. Samples 25c. Large assortment $1.00. Straley, 1013 Mulberry, Springfield, Ohio.

4 MOST read Mail Order magazines 15c. Armand Cartier, 695B, North Pittsfield, Mass.

THRILLING art photographs! Big assortment, $1. Photoprints, 202-P Madison, San Antonio, Tex.

UNCOMMON books; lists sent. Mention interests. Doherty, 5322 Ludlam, Chicago.

BOOKS on every Sport. Catalog free. Ballard, 670 E. 42nd, Brooklyn, N. Y.

OUTDATED Magazines. Catalog 10c. Cicerone's, 863 First Avenue, New York, N.Y.

BUILD IT YOURSELF

BUILD your tractor from second-hand automobiles! Convert your horse drawn farm equipment into tractor drawn equipment. Nolan's Garage, East Wareham, Mass.

BUILD Streamlined plywood kitchen cabinets. Plans 25c. Roger Underwood, 4617 Johnson Ave., Western Springs, Ill.

LATHE Tool Post Grinder, Castings, Building Instructions $2.50. Particulars 10c. Star Machine Shop, Kingfisher, Okla.

BUSINESS OPPORTUNITIES

PLASTEX Industries offer industrious men an opportunity to start a business of their own, manufacturing art goods, novelties and utility products in Plastex and marble imitation. ½c material makes regular 10c store seller. Rubber molds furnished for speed production. Small investment brings big returns. We are now placing big chain store orders with manufacturers. Ambitious men have chance for real prosperity. Plastex Industries, Dept. S., 1085 Washington Ave., New York, N. Y.

BUILD your own Business! Popular Science Classified ads will introduce your products into over 700,000 homes. These small ads have helped build big businesses. Send us a description of your product. We will submit full information and suggested ads for your approval. O. K. Kelly, Classified Mgr., Room 1100, 353-H Fourth Ave., N. Y. C.

BRUSH Plating outfits connect to a battery, no tanks necessary. Almost as simple as painting. Your opportunity to make good income plating autoparts, bathroom fixtures, reflectors, mirrors. Get free proof and particulars that put you in a paying business of your own. Gunmetal Co., Ave. E, Decatur, Illinois.

START Home Business making statuary, plaques, art goods, novelties, souvenirs, concrete pottery, garden furniture, artificial marble flooring, liquid marble. Make your own flexible molds. Amazing profits. Valuable folder free. Creative Publishers, PS11, Glencoe, Illinois.

MECHANICALLY Inclined Men—Own and operate general Appliance Repair shop. Complete, illustrated course shows you how. Welding, Refrigeration, Motor repair. How to get business, etc., all phases covered. Free literature. Christy Supply, Dept. 322, 2835 N. Central Ave., Chicago.

COLOR Concrete with chemicals. Stucco-rock. Cement Artistry. Wishing-wells. Spin concrete pottery. Benches. Garden Ornaments. Cold-glaze concrete-paints, marbling. Sample 10c. Hollywood Cement-Craft, 8530 Wonderland, Hollywood, Calif.

DEVELOP Upholstery Cleaning Business. Big profits supplying local demand. Your own business. No priorities. Write for free literature. Shinette, 26218 Atlantic, Brooklyn, N. Y.

FIRE detector unit, patented, underwriters labeled, complete manufacturing equipment. Sell outright, high priority rating. Distributors wanted. A. Moss, 4046 Chouteau Ave., St. Louis, Mo.

MAKE Artificial marble, glazed tiles, plaques, flooring, pottery, novelties. Cement secrets, uncanny. Beautiful samples free, Payn, 945 Grande Vista (Room 102), Los Angeles, Calif.

FOR an extremely profitable lifetime business, operate a Collection Agency-Credit Bureau. Many make $4,000 yearly, up. Write, Cole Associates, Syracuse, N. Y.

MAIL Dealers Wanted. Chance to realize $1,000 on 50c investment. Stamped envelope brings particulars. Postals ignored. Ornsteen, 1811 Adams, Chicago.

ESTABLISH profitable business selling correspondence Courses. No stock to carry. Big demand. Write, Howard, 430 Dearborn, Buffalo, N. Y.

127 WAYS to make money in home or office, business of your own. Full particulars free. Elite Co., 214-A, Grand St., New York.

SWISS Music Box Works—$1.65 to $2.25. Suitable for many novelties. Mermod Manufacturers, 147 West 46th Street, New York.

BECOME Independent! Start your own business. Plan and Win. Profits Large. Experience unnecessary. Gerson Bearman, 5105 Levindale Road, Baltimore, Md.

SELL by mail. Suggestions Free. H. R. Dean, 1828 Ave. L, Galveston, Texas.

START your own magazine agency at home. No capital required. Write for particulars and supplies. American Readers' Service, Hatfield, Pa.

FREE—200 clever mailorder, homework, local business offers—all snappy money-makers. Lewis Co., 638-K Carpenter, Oak Park, Ill.

LIQUID Marble — Marvelous, colorful! Brushed, sprayed, molded. Rubberlastic molds! Composition Flooring! Particulars free. Marbleizing Service, Edwardsville, Ill.

RAISE Angora Wool Rabbits for wool and meat. Easy, profitable business. Booklet, prices, etc. 10c. Harder Farm, Route 2, Salem, Oregon.

$24,500 RICHER; used Schemes from "Schemer" Magazine, Alliance, Ohio. Get Next! Three months just 30c.

MAKE money collecting accounts. Good income; quick results. Collectors Association, Newark, Ohio.

FREE—1000 moneymaking opportunities. Northcrest Publishers, 2001 Milton, Muncie, Ind.

LETTERSHOP, the versatile business. Operate anywhere. Tremendous profit. Professional Products, Sta. M., Cincinnati.

WEBER Typewriter Mechanics School. Simplified homestudy. Repairing increasing. Canton, Ohio.

FREE literature describing many money making plans. Krach Service, 9901 Union Ave., Cleveland, Ohio.

BECOME A Finance Man. Particulars free. Nebraska Finance Co., Lincoln, Nebraska.

INTERESTED in Real Plastics? Send stamped envelope. Box 498, Gainesville, Texas.

$50—$100 WEEKLY using Sawdust. Stamp Please. Clement, 843 Arthur St., Rochester, N. Y.

EARN $20.00 daily doing simplified bookkeeping locally. Write, Thrif-Tee, Danville, Illinois.

RAISE Angora rabbits—wool brings $5.00 pound. Particulars free. Grinstead's, Edwardsville, Ill.

BUSINESS SERVICE

DO you have something to sell to our 731,158 readers? If so, ask for our free folder of "10 Reasons" why classified advertising in Popular Science gets profitable business. O. K. Kelly, 353 Fourth Avenue, New York City.

FIVE reasons how collect delinquent accounts, keeping customers. One dollar. General Adjustment Co., Jordan Bldg., Waco, Texas.

RURAL, small town, women buyers—2,000 $5.49. Lederer, 17 Guilford Avenue, Baltimore.

SIGNS, Show-Cards—Hand drawn, attractive, colorful, sales-stimulating. Low cost. Heise, 4011 Canal, Houston, Texas.

TRANSLATIONS—All foreign languages, reliable. Translation Bureau, 1182 Broadway, New York.

MAIL Advertiser Monthly—sample copy, 5c. Okay Company, Martins Ferry, Ohio.

MILLION names, various kinds. State needs. Q Service, 339 S. Wells, Chicago.

CAMERAS, PHOTO SUPPLIES

WRITE Bass First—Largest stocks of fine cameras, (still and movies) in the U.S.A. Latest Argus C-3 with coupled range finder, synchro flash, 50mm. F:3.5 lens; also 75mm. Bausch & Lomb Telephoto F:5.6, also coupled to range finder, $82.55 value, price—$60.50, unconditionally guaranteed. Cowhide Eveready case, $4.75. V. P. Ihagee, F:4.5 Anastigmat, Prontor shutter, $16.75. Whatever you want in photography, write Bass first. Liberal trades. For over thirty years, money back if not satisfied. Bass Camera Company, Dept. S.P., 179 W. Madison Street, Chicago, Ill.

STILL Available At Central—Hundreds of bargains in Cameras and Supplies. Send for free illustrated catalog listing still and movie cameras, films, lenses, enlargers, meters, supplies—at tremendous savings—all guaranteed. Trade in your old camera or equipment. Write for your free copy of newest money-saving bargain book—just out! Limited edition. Hurry! Central Camera Co., (Photographic Headquarters since 1899), 230 S. Wabash Ave., Dept. K-182, Chicago, Illinois.

PHOTOSTAMPS—From any photo. Send stamp for samples. Stampstudios, 82-29 60 Road, Elmhurst, N. Y.

AMATEUR Photographers attention! Improve your hobby of picture taking and learn how to make money with it. Write today for our 40-page book catalog and a sample copy of American Photography, enclosing ten cents for postage. Contains articles and pictures of the world's foremost writers and pictorialists. Camera House 141, 353 Newbury St., Boston, Mass.

CASH! Spot cash for cameras, lenses, binoculars, movie or still, sound projectors. Send full description by mail, or wire for prompt cash offer. Over 30 years of dependability insures honorable dealings. Bass Camera Company, 179 West Madison Street, Chicago, Illinois.

MAKE money in photography. Learn quickly at home. Easy plan. Previous experience unnecessary. Common school education sufficient. Booklet and requirements free. American School of Photography, 1315 Michigan, Dept. 1746, Chicago.

PHOTOGRAPHY is a leading hobby of Popular Science readers. This column offers an economical way to reach them. Advertise your product here and get more business! Classified Adv. Dept., 353 Fourth Ave., New York City.

OIL coloring photographs a fascinating hobby or profitable business. Learn at home. Easy simplified method. Previous experience unnecessary. Send for free information and requirements. National Art School, 1315 Michigan, Dept. 1741, Chicago.

SPEED-O-COPY groundglass focusing attachment for Leica, Contax, Argus C-2 and C-3. Send for literature. D. Paul Shull, Dept. PS-11, 240 So. Union Ave., Los Angeles, Calif.

CAMERA Repairing. Bellows made to order, shutters repaired. Bellows made to fit all standard cameras! United Camera Co., Inc., B-1515 Belmont, Chicago.

CARTOONING, SIGN PAINTING, DRAWING AIDS

CARTOONING Course—36 lessons, 6 booklets, 816 illustrations—$2.80. (Satisfaction guaranteed). Templeton Studios, Wellington's, Elgin, Illinois.

EARN money evenings, copying and duplicating comic cartoons for advertisers. Comic-Ads, Argyle, Wisconsin.

CHALK TALK STUNTS

LAUGH producing program, $1.00. Illustrated catalog 10c. Cartoonist Balda, Oshkosh, Wis.

CHEMICALS & APPARATUS

CHEMISTRY Laboratory apparatus and chemicals for industrial, analytical, and experimental laboratories. Complete supply service for students taking correspondence school chemistry courses. Send 3c postage for free 44 page catalog. Dept. M26, Biological Supply Co., 1176 Mt. Hope Ave., Rochester, N. Y.

CHEMICAL Magic made easy! Baffle your friends with startling tricks and stunts. The Home Chemist shows you how! 192 pages, illustrated. Only $1.00! Dept. C-112, Popular Science, 353 Fourth Ave., New York.

WINN'S new idea Home Laboratory Chemical Kits and apparatus outfits for home experimenting. Send 3c for literature and retail supply catalogue. J. H. Winn Co., Dept. 611, 124 W. 23rd St., N. Y.

FREE Catalog: chemistry, mineralogy, biology. Special: 28 piece chemistry set, send $1.00. Tracey Laboratories, Evanston, Ill.

LABORATORY Supplies at Wholesale Prices: Chemistry, Biology, Physics, Catalogue, 10c. National Scientific Co., 2204 W. North Ave., Chicago. Established 1908.

LUMINOUS Paints will glow in dark. Six colors. Fairmount Chemical Co., 126 Liberty St., New York City.

CHEMISTS. Chemical questions answered 25c. Formulas, analyses, minerals. Lewitsky, 26 Erwin Place, New Britain, Conn.

CATALOG 3000 Illustrations 10,000 prices. Sent for 50c. Laboratory Materials, 7317 Vincennes, Chicago.

CHEMICAL Magic Set performs mystifying experiments, 50c. Chem-Lab, Harvey, Ill.

POWDERS—Any mesh; any material. Wm. Croll, Box 562, Norristown, Pa.

SPECTROSCOPE for quick chemical analysis $2.50. McCutting Sons, Campbell, Cal.

DETECTIVES

DETECTIVES—Work home—Travel. Experience unnecessary. Write, Wagoner, 2640-P Broadway, N. Y.

DETECTIVE training-Secret investigations -Easy method-Fingerprints. Booklet Free. International Detective System, Box 756-P, Journal Square, Jersey City.

DOGS, BIRDS, PETS

PUPPIES! Many breeds—particulars free! Book 108 colored pictures, descriptions recognized breeds, 35c. Royal Kennels, No 80, Chazy, N. Y.

ST. BERNARD puppies. Champion sired beauties. Franklin Young, RJ, Riverhead, Long Island, New York.

DRAFTING INSTRUMENTS

TRANSPARENT Trig Protractors Engineering Mechanics do all .0000 natural functions sine, cosine, tangent, cotangent, secant, cosecants in position 0 to 90 degrees, $1.50 postpaid. Refund guaranteed. Trigoscope, 614 5th Ave., Coraopolis, Pa.

DRAFTING Instruments or Supplies. Free Bargain Catalog. Gordon's, 162-PS Madison, Chicago.

EDUCATIONAL & INSTRUCTION

MANY opportunities await well trained men. If you want to study at home to prepare for better pay, consult this column. Answer the opportunities that appeal to you most and obtain full information.

WELDING—Electric Arc. Learn quickly by actual practice at Hobart Welding School. Individual instruction at bare cost of materials used. 50c in stamps brings valuable welding lessons post paid and full particulars. Hobart Welding School, Box P-1122, Troy, Ohio.

GOOD "used" educational books on all subjects bought, sold, rented, exchanged. Satisfaction guaranteed. Free 76-page illustrated bargain catalog now ready. Get it without obligation. Write today. Nelson Company, 500 Sherman, Dept. L-203, Chicago.

RADIO engineering, broadcasting, aviation and police radio, servicing, marine and Morse telegraphy taught thoroughly. All expenses low. Catalog free. Dodge Institute, 500 Monroe, Valparaiso, Ind.

WANT A Gov't Job? $105—$175 month. Big opportunity. Prepare immediately for new examinations. List positions—full particulars Free. Write today. Franklin Institute, Dept. S-31, Rochester, N. Y.

FREE—100 page Book Catalog. New & used college & home study text & reference books at a saving. Est. 1902. We also buy books. College Book Co., Dept. 5, Columbus, O.

LEARN Telegraphy! Splendid opportunities now prevail. All expenses low. Catalog free. Dodge Institute, 501 Monroe, Valparaiso, Ind.

FINGER Print Experts earn big pay! Learn easily at home. Low cost! "Crime Book" Free. Write stating age. Dept. 29, Inst. Applied Science, 1920 Sunnyside, Chicago.

CLINICAL Laboratory Technic taught in your own home. Practice outfit supplied. Bulletin free. Imperial Technical Institute, Box 973-B, Austin, Texas.

MIND Healing—The key to successful Living. First complete lesson sent prepaid for 2 dimes. Success Club, 4139 Second, Detroit.

RADIO Communications courses qualifying for all Federal licenses. Home study and resident courses. American Radio Institute, 1123 Broadway, New York, N. Y.

DRAFTING and Mathematics courses. Each $1 complete! Free circular. Write Giles, 1326 Myers, Burbank, Calif.

HOME Study Course, Drugless Therapy. Free literature. Drugless Therapy Inst., Tama, Iowa.

FREE illustrated lesson handwriting analysis. Examination free. Donaldson, Linn Creek, Mo.

LOCKSMITH Course. Lock-picking, key-fitting, etc. $1.00 prepaid. Miller's Key Shop, Canadian, Texas.

ELECTRICAL SUPPLIES & EQUIP.

FREE! 1942 Catalog—1000 electrical bargains. LeJay Manufacturing, 823 LeJay Bldg. Minneapolis, Minn.

ELECTRIC Pencil: Writes—Engraves all Metals. $1.00 postpaid. Beyer Mfg., 4515-C Cottage Grove, Chicago.

ALNICO Magnets. Circulars 5c. Terry Sales, Central Sta. 1676, Toledo, Ohio.

ENGINES, MOTORS, ETC.

WINDING Data, 225 motors, single and three phase, $1.00. Motor Data, Box 7631, Kansas City, Mo.

½ HORSE, 3450 Speed, Repulsion Induction Alternating Motors $12.50; 500 Watt, Alternating Current generators $29.50; other sizes. Butler Electric, 1885 Milwaukee, Chicago.

½ HORSE, 110 volt, induction motors, Rebuilt, guaranteed $9.75; other sizes, Wilmot Auto Supply, 2247 St. Paul Ave., Chicago.

FARMS, OTHER REAL ESTATE

GOOD Farm Bargains. Washington, Minnesota, Montana, Idaho, Oregon, North Dakota. Dependable crops, favorable climate. Write for literature and lists describing farms for sale. Specify state. J. W. Haw, 120 Northern Pacific Ry., St. Paul, Minn.

SEE The Highlands of Louisiana. Choice cut-over land selling on liberal terms. Descriptive book sent upon request. Long-Bell Farm Land Corp., 874 R. A. Long Bldg., Kansas City, Mo.

STROUT'S Catalog just out! Farms, country homes, rural business opportunities; 64 pages chock-full of bargains described in states east of the Mississippi. Write today for this money-saving, time-saving guide. Free. Strout Reality, 255-ZB 4th Ave., N. Y. C.

40 ACRES, near White River, unimproved; poultry land, $190; $5 down, $5 monthly. Free list and literature. Hubbard, 269 Grossman Bldg., Kansas City, Kan.

FLORIDA—5 acres, ideal for fruit, vegetables; close to fine ocean beach, $485. Easy terms. Write for free literature. Box 1944, Orlando, Florida.

FIELDGLASSES, TELESCOPES & MICROSCOPES

BINOCULARS and microscopes—All makes—Domestic and foreign binoculars and microscopes repaired, replacements made and accurately collimated. Prices reasonable. Three days service. Maryland Precision Optical Co., 1 & 3 North Carey St., Baltimore, Md.

LENSES—Build your own telescope, field glass, microscope, riflescope, etc. Assortment of fifteen lenses—$1.00 postpaid. Thirty lenses—$2.00. Slightly chipped on edge. Satisfaction absolutely guaranteed. American Lens Company, 1313 Vine Avenue, Park Ridge, Illinois.

ASTRONOMICAL Telescopes, binoculars, cameras, microscopes: bought, sold, repaired. Send 10c for list of instruments desired. Rasmussen, Box 294, Amsterdam, N. Y.

FOR INVENTORS

INVENTORS: Take first step toward protecting your invention—without obligation. Write for Free "Record of Invention" form for establishing date of invention, and free "Patent Guide for the Inventor"—telling about confidential search service; how to sell inventions; convenient payment plan. Send for "Patent Guide" and "Record of Invention" form today. Clarence A. O'Brien and Harvey Jacobson, Registered Patent Attorneys, 22A-L Adams Building, Washington, D. C.

INVENTORS—Industry needs your ideas now! Manufacturers are getting ready Now for post-War sales and production. Factories must have products to take up the slack after war orders stop. Get our New Free inventor's book today and valuable "Invention Record" form. Act now. McMorrow and Berman, 143-F Barrister Building, Washington, D. C.

INVENTORS:—Entirely new products are urgently needed for the drastic changes in our every-day needs. If you have a practical, useful non-military invention it can now be sold safely, without patenting expense. Write today for complete details. Chartered Institute of American Inventors, Dept. 3-A, Washington, D. C.

115 MECH. Movements—Just what you may need to complete your invention. 48-page illustrated book contains valuable information for inventors. Yours—Free. Write today. Victor J. Evans & Co., 642-M Merlin Building, Washington, D. C.

FREE booklet "Why Invent" Shows sure way to success. Don't attempt selling or patenting your invention before you have read it! Invention-Service Company, Dept. B, Professional Arts Building, Hagerstown, Md.

CASH for practical ideas and inventions. Mr. Ball, BB-9441 Pleasant, Chicago.

FORMULAS, PLANS, ETC.

AUTHENTIC Formulary 924 pages (illustrated). 10,000 Money making formulas, recipes, instructions, substitutes. $1.75 postpaid or C.O.D. (Foreign, $2.10). Catalog, 3c. Adams Brown, Chestnut Hill, Mass.

ABSOLUTELY any and every formula, analysis, or process completely described, $1.00. Guaranteed successful! Information research Institute, Box 8725, Pittsburgh, Pa.

TWO tire saving formulas. Complete instructions, Ten cents, Hiawatha Supply, Newberry, Michigan.

FLEXIBLE Molds for Plaster Casting. Newest sensation. Details Free. Deb Dykes, 918 Alabama, St. Joseph, Mo.

23 YEARS supplying authentic formulas. Catalog Free. Grinstead, Edwardsville, Illinois.

24 FORMULAS and trade secrets, 35c postpaid. H. Tooker, 630 Chestnut, Hamilton, Ohio.

FORMULAS, All kinds, Guaranteed. Catalog, stamp. Kemico, 500, Parkridge, Ill.

HELP WANTED

MEN wanted for old Rawleigh Routes which have paid our Dealers big for years. Over 200 farm-home necessities. Old established demand. Low wholesale prices. Good cash profits. No age limits. No layoffs. If you will work steady for good pay, write. Give age, references. Rawleigh Co., Dept. K-159-PSC, Freeport, Ill.

MEN! Make money! Write for gorgeous presentation world-famous Stark quick-bearing Fruit Trees. Take easy orders from farmers, gardeners, home owners everywhere. Big profits. Experience unnecessary. Outfit Free. Write Stark, Dept. C-128, Louisiana, Missouri.

STEADY Work—Good Pay. Reliable man or woman wanted to call on farmers. No experience required. Pleasant work. Home every night. Make up to $15.00 in a day. Wonderful new proposition. Particulars free. McNess Co., Dept. 626, Freeport, Ill.

CALL on friends with sensational Personal Christmas Cards from 50 for $1.00 up. Stationery. Also magnificent 21 card $1.00 Assortment. Profit 50c. Experience unnecessary. Samples on approval. Wallace Brown, 225 Fifth Ave., Dept. O-35, N. Y.

HIGHGRADE SALESMEN

WANTED—Unusual salesmen for an unusual job. It's permanent, practically a business of your own, becoming more and more valuable. It's selling but selling largely by counseling. You are backed by strong national advertising and by many user-boosters. No priority troubles and war conditions work with you in many ways. Requirements: Good personality and character; a will to work. Liberal commission arrangement. LaSalle Extension University, nationally-famous correspondence institution. Write fully about yourself to John D. Morris, 4105 S. Michigan, Chicago.

ADVERTISING Book Matches offer liberal earnings—full, spare time. Experience unnecessary. Factory direct. Low prices; high quality; quick deliveries; powerful patriotic display; repeats. All business firms prospects. Free kit, instructians. American Match & Printing Co., Dept. 711, 4822 South Trumbull Ave., Chicago.

ADVERTISING Book Matches. America's largest manufacturer of Union Label Book Matches. Fast selling line. Large sales producing kit. Sample matches. Complete cut catalog. 17 color combination makes selling easy. Commission in advance. Superior Match Company, 7530 Greenwood Ave., Dept. P-11, Chicago.

NEW Air Raid Shoe sweeps country. Zips on—zips off. No fumbling or breaking of laces in blackouts or when alarm sounds. Huge profits for direct salesmen and women. Hundreds of other fast-selling shoe styles. Write for free sample shoe outfit. Victor Thomas Shoe Co., 610 W. Van Buren St., Dept. V-65, Chicago, Ill.

RELIABLE man wanted by nationally-known manufacture.-jobber to contact merchants in own town. Steady, big pay; opportunity to develop own independent business. Start full or part time. Sales experience unnecessary. Laymon, Dept. 83-X, Spencer, Ind.

YOUR ad in this Classification will reach productive sales-getters for your products or services. Cost is low! Rates on request. Popular Science Classified, 353 Fourth Ave., New York, N. Y.

IF you are ambitious you can make good money with a Rawleigh Route. We help you get started. No experience needed to start. Steady work for right man. Write Rawleigh Co., Box K-2-PSC, Freeport, Ill.

CALENDARS—Fans—Novelties—Beautiful Complete Lines all sizes, including Jumbos. Samples free. Start now, be first in field. Fleming Calendar Co., 6539 Cottage Grove, Chicago.

HOBBIES, COLLECTIONS

BEAUTIFUL Abalone Shells—Brilliant finish! Make beautiful gifts and decorations. 12 assorted, prepaid, $1.00. Abalone Shells, Box 66, Rockport, Calif.

20 DIFFERENT cactus plants postpaid, $1. Eulalia Turner, Azusa, Calif.

HOME CRAFTSMEN

25 LAWN Ornament patterns 25c. Other patterns: 15"-20" high; Dutch girl, Dutch boy, pirate, bull terrier, Mexican girl, Mexican boy, dwarf, penguin, flower girl, 10c each; 3 for 25c. 25 Novelty patterns, 30c. All 62 full size patterns $1.00 postpaid. Strother, Box 383-DZ, Belington, W. Va.

BIGGEST craft-plan bargain—48 complete plans $1. What-not shelves, garden ornaments, ash trays, Dutch boys and girls, toys, bird houses, and many other interesting projects. Finest selection available. Novel method allows you to make finished product any size desired. Jackson Studio, Dept. PS10, Shorewood, Wis.

CATALOG:—Patterns plywood novelties. Lawn ornaments, silhouettes, letters & numerals. Decal transfers, handy hand tools, new power sander. Other lines. 500 articles finely illustrated. Write today. Wo-Met Shop, Ashburn, Georgia.

TO get more business, advertise your projects for Home Craftsmen in this column. Cost is low. Details on request. O. K. Kelly, Classified Adv. Mgr., 11th floor, 351 Fourth Ave., New York City.

LEATHERCRAFTSMEN: Send 10c for handbook and catalogue of tools and supplies. E. A. Sweet Co., Inc., Leathercraft Division S-28, 148 State St., Binghamton, N. Y.

GET Free leathercraft instruction pamphlets, prices of leathers, tools, projects. Fascinating Hobby. Make gifts. Leather samples 5c. Wilder & Company, 1038 Crosby, Dept. A-11, Chicago, Ill.

KNOCKDOWN cedar chest, lumber, veneer. Illustrated catalog, 10c. Giles-Kendall Co., Decatur, Alabama.

PHONOGRAPH Motors $2.00 to $7.00; useful for many interesting inventions. Mermod, 147 West 46th Street, New York.

INFORMATION

WHAT? When? Where? How? Who? Why? All questions answered. Formulas, problems, dates, methods, people. Any subject! Send questions—No money! Pay $1.00 when answered. 3 day service. Satisfaction guaranteed. Information Research Institute, Box 8725, Pittsburgh, 21, Pa.

INVENTIONS WANTED

INVENTORS: — Manufacturers urgently need new ideas for drastically altered civilian markets. If you have a useful new invention, or a practical improvement on an already established product, you can now sell it safely without patenting expense. Complete details, Free. Chartered Institute of American Inventors, Dept. 3-C, Washington, D. C.

CASH for Inventions—Patented, unpatented. Mr. Ball, BC-9441 Pleasant, Chicago.

INVENTIONS Promoted. Patented or unpatented. Write Adam Fisher Co., 183-A Enright, St. Louis, Mo.

INVENTORS! Have you good, patentable idea? Write—Mr. Metzler, 11 West 42nd, New York.

MANUFACTURER wants new invention or ideas. Nelson, P. O. Box 626, St. Paul, Minn.

MACHINERY, TOOLS & SUPPLIES

PLANS for making internal Keyway cutter lathe attachment. $1.00. Cut square holes, broaching, etc. Hobson, 422 So. Dearborn, Chicago.

AIR Compressors Twin cylinders $8.00—Motors ½ horse power $6.00, 907 North Fifth, Philadelphia.

GRIND Drills Like Factory: Attachment for Bench Grinder. Cheap. Factory, 811-A East 31, Kansas City, Mo.

I BUY machines and tools for wood and metal working. One tool or complete shop. Wooden planes, chests, benches. Every kind of tool, new, used or broken wanted. Engines, motors, household appliances, etc. in any condition wanted. Postal brings my "wanted quick" circular. You need "Brinks Bargain Bulletin," gives auction prices on machines and tools, new and used for all shops, next issue sent for 28 cents, one year with weekly specials for $1. List of all our circulars for 3 cents, sent free if requested on letterhead. Large quantity machine screws, rivets, small eye bolts for delivery without priority. H. A. Brinkerhoff, Inc., 37M Walker St., New York City.

RECLAIM dull and broken drills with Nu-Way Drill Grinder. Circular free. Tractor-Lite Mfg. Co., Sidney, Iowa.

MAGIC TRICKS, PUZZLES, JOKER NOVELTIES

DOUGLAS' famous 1942 catalog of 500 tricks you can do! Brand new effects for pocket, parlor or stage. Send 10c for year's biggest catalog value. Douglas' Magicland, Dallas, Texas.

MAGIC tricks, apparatus, illusion plans, joker's novelties, luminous paints and items. Catalog, 10c. Mac's Magic Shop, 506-B-Main, Ft. Worth, Texas.

WORLD'S largest professional magic shop keeps you in touch with latest tricks. To receive mailings send 25c for 1942 catalog. Holdens, P-220 W. 42nd St., New York.

MAGICIANS', Gamblers' secrets exposed. Cards, Dice, Punchboards, Slot Machine. Catalog 10c. Book Co., Box 671, St. Louis, Mo.

MARKED coin produced from sealed bag inside two sealed boxes. Anybody can perform. Price 50c. Exceptional Mysteries, Marion, Ohio.

HOLLYWOOD Special! Magicians button, catalog, ghost illusion and free trick for 25c. Magic House of Charles, Box 888S, Hollywood, Calif.

LEARN Ventriloquism. Send for free folder. State age. Fred Maher, 1701-N Casgrain, Detroit, Michigan.

MAGICIANS' headquarters. 216-page illustrated catalog, 25c. Kanter's, S-1311 Walnut, Philadelphia.

JOIN Magicians' Fraternity! Free tricks! Monthly magazine, sample 10c. International Magicians, Mt. Morris, Illinois.

LEARN Magic. Copyrighted trick Free. Harry V. Willis, Box 1704, Cleveland, Ohio.

DOLLAR Magic Set Free with colossal catalog 25c, Trixie, 2404 N. 15th, Phila.

MINERALS & PRECIOUS STONES

24 BEAUTIFUL ore specimens—copper, gold, silver, moly, manganese, etc., about one inch size. In attractive display carton. Postpaid to any U.S.A. address, one dollar. Satisfaction or money refunded. Arizona Mineral Specimen Co., Cherry, Arizona.

BEAUTIFUL Jewelry Stones removed from rings, etc. 100 assorted $2.00. Lowe's, Box 311, St. Louis, Mo.

MISCELLANEOUS

MEDICAL Laboratory Technicians in great demand. We train you in your spare time, in your own home. You can practice while studying. Write for free catalogue. Imperial Technical Institute, Box 973-S, Austin, Texas.

DEAFNESS. Why? Good hearing without mechanical aids. No drugs. Relieving deafness, Johnston, Sta. C, Vancouver, Canada.

COLCHICINE—Evolution chemical creates new, mutant plants. Illustrated booklet plus Experiments magazine, 25c. Questop, Wellesley, Massachusetts.

HIGH class violins for orchestra work, moderately priced, shipped on approval. Address: Hardwick the Violin Maker, Grand Valley, Colo.

RECEIVE gigantic mails, magazines, samples. Your name in numerous mailing lists 10c. Howard, 396 Broadway, New York.

PRETTY Girl pictures, books, novelties. Sample assortment $1, Catalog 10c. Wm. Braun, 353 W. 47th, Chicago.

CONQUER illegal coin machines! Particulars, 3c stamp. Devereaux, Box 212-P, Battle Creek, Mich.

UNPAINTED Wall Plaques 5c each, 24 different samples $1.00. Oman, 642½ Broadway, St. Paul, Minn.

FREE literature how to locate buried treasure and minerals. Fisher Laboratory, Palo Alto, Calif.

PLEASANT Surprise—for your name and address on postcard. National Mail Service, 1504 Dodge, Omaha, Nebraska.

5x7 PHOTOGRAPH, 1850 wood burning locomotive, 25 cents coin. Locomotive, 1830 Wood, La Crosse, Wisconsin.

FERRETS—Kill your rats with ferrets. Henry Hainline, Creston, Iowa.

HEATING six rooms $20.00 yearly. Circulars 10c. Rosenzweig, RR10-B10, Cincinnati.

MODELS & MODEL SUPPLIES

BUILD Beautiful Ship Models! New 192-page book, "Ship Model Making," gives easy, step-by-step instructions. Complete plans for Spanish Galleon, Clipper Ship and Racing Yacht. Only $1.00! Dept. C-112, Popular Science, 353 Fourth Ave., N. Y. C.

CARVED hull ship model kits. Ship & Yacht model fittings, sails, spinnakers. 32 page illustrated catalog 20c. A. J. Fisher, 1002-6 Etowah Ave., Royal Oak, Mich.

MOST complete Illustrated Catalog—"O-HO OO" Model Railroad Parts ever published. Send 5c for mailing. Selly, 1377 Gates Ave., Dept. 810, Brooklyn, N. Y.

RAILWAY models, complete line informative catalogs. O Gauge 112 pages, 25c. HO 48 pages, 15c, Walthers, 269 Erie, Milwaukee, Wisconsin.

1942 MODEL Ford cars in miniature. Send stamp for all makes. P. O. Box 133, Hemingway, S. C.

SHIP Model and yacht supplies, complete large 56 page Catalogue, 15c. Wm. Wild, 510 E. 11th St., New York City.

MONEY MAKING OPPORTUNITIES

LEARN Metascience. Remarkable drugless healing. No manipulation. No apparatus. Unbelievable simplicity and results. Inexpensive correspondence course. Write Metascience, De Land, Florida.

JUST Released! 3 moneymaking home-plan formulas, showing you How, What to do! Guaranteed results! 25c (coin) buys complete business setup! McDougle, Box 564, Birmingham, Alabama.

TWENTY money making secrets—formulas, business plans, trade secrets, 35c postpaid. H. Tooker, 630 Chestnut, Hamilton, Ohio.

GAMBLERS Secrets Exposed! Information free. Jesse Hales, 233 S. 4th East, Salt Lake City, Utah.

"RAISE Earthworms for Profit". Interesting home business. Bureau Zoological Research, 106A Broadway, Peoria, Ill.

MAILORDER Income. Boundless opportunities. Particulars Free. MacMillen, 273D, Lancaster, Ohio.

EARN money evenings, copying and duplicating comic cartoons for advertiser. Comic-Ads, Argyle, Wisconsin.

AMAZING mailorder opportunities, $1. To start, literature Free. Harvey Teeple, (PS) Decatur, Ind.

WRITE to Val-U Publishing Co., Box 230, Burbank, Calif. for free money-making opportunities.

MAKE $75 A Day. Instructions 10c. Raymond Tilbury, Guthrie, Okla.

INVESTIGATE "War Money In Mail Order", Cutler Publishers, Reading, Pa.

MONUMENTS

MONUMENTS—Direct Low Prices, Freight paid. Guaranteed. Free Catalog and samples. Write Granite-Marble Factory, A49, Oneco, Florida.

MOTION PICTURE & SOUND EQUIPMENT

COMPLETE 8-16MM. Silent-sound subjects—$1. Need splicing. All sizes film, bought, sold, exchanged. Arts-catalogue-sample film 10c. International-S, 2120 Strauss, Brooklyn, N. Y.

RENT-Buy-Sell. 8mm-16mm movie equipment, films. Save 50%. Catalogues for 10c. Don Elder's, M-739 Boylston, Boston, Massachusetts.

KODACHROME film subjects for grown-ups, 8-16MM. Unusual subject matter. Lists, color sample, 10c, Jenkins, 392K, Elmira, N. Y.

ESO-S Univex and double 8MM spooled, bulk films save you 50%. Particulars, Eso-S, 3947 Central, Kansas City, Missouri.

ART Subjects (Catalogue-Sample 10c). Midwest Cine Shop, Hannibal, Missouri.

16MM Films exchanged, 400-ft. reel; silent—$1.00, sound—$2.00. Latest releases. Free 40-page catalogue. Better Films, 742 New Lots Avenue, Brooklyn, N. Y.

"THE World's Greatest Passion Play". Large rental library 16MM, 35MM, sound and silent. Write Hemenway Film, 33-Z Melrose St., Boston, Mass.

LATEST film lists and equipment. New film exchange. Paramount Mfg. Company, M-22, Box 224, Back Bay, Boston, Mass.

LEARN Movie Projection, Management. Free catalog. Give age. Theatre School, Elmira, N. Y.

100' 16MM. Used sound films, $1.00 postpaid. Blackhawk Films, Dept. PS2, Davenport, Iowa.

FREE, Movie Catalog; sample films 10c. Also Kodachrome (colored) pictures. Goodwill Company, Jackson, Tennessee.

$1 BRINGS "Surprise" assortment, 8MM colorful titles! LeMoine Films, Nevada, Mo.

A 1½c STAMP brings our 16mm, 8mm catalogue. Sterling's, 679 Northampton, Easton, Pennsylvania.

DEVELOP your own 8-16MM. Movies. Save 60%. Bulk films—developers. Write Genera Company, Davenport, Iowa.

SALE, Rent, Exchange—8-16MM. Home Movies. Free catalogue. Bailey Films, 1653 Cosmo, Hollywood, Calif.

MOTORCYCLES, BICYCLES & SUPPLIES

SAVE tires, gasoline. Send dime for list nearly new and rebuilt motor scooters, motorcycles. Hurry if want one, last call for duration. Clymer, 307 W. Pico, Los Angeles, California.

SCOOTER Tires, Wheelbarrow, Trailer, Midget-car, all sizes. Also bicycles, accessories, etc. Send 10c for list. Cycle Transport Co., 82 W. Washington St., Chicago, Ill.

MUSIC, MUSICAL INSTRUMENTS

MUSIC composed to words. Rhyming pamphlet on request. Phonograph recording of completed song. Send poem. Keenan's Studios, Dept. PS, Box 2140, Bridgeport, Conn.

SONG Poems Wanted. Send for free instructive booklet. United Music Corporation, Dept. 31, Salem, Ind.

LEARN Swing piano! Postal brings free folder. Christensen, 465 Kimball Hall, Chicago.

WANTED—Piano accordions—any condition. Send description. Immediate cash, Chaton, 600 Blue Island, Chicago.

WANTED! Lyrics, melodies for songs. We arrange, publish, sell. Superior Song Studios, Passaic, N. J.

OLD GOLD, WATCHES, PRECIOUS STONES

GOLD $35.00 Ounce—Mail old gold teeth, diamonds, jewelry, watches—receive cash by return mail. Satisfaction guaranteed. Free information. Dr. Weisberg's Gold Refining Co., 1500-B Hennepin, Minneapolis, Minn.

ELGIN, Waltham Watches. Attractive buys. Make big money. Free Watch and Jewelry Catalog. Plymouth Jewelry Co., 163-B Canal St., N. Y.

CASH! Gold, jewelry, teeth, coins, diamonds, mercury, etc. Ship! Simon's, 353 Old Arcade, Cleveland, Ohio.

OLD STAMPS WANTED

I WILL pay $100.00 each for 1924 1c green Franklin stamps, rotary perforated eleven (up to $1,000.00 each unused). Send 6c today for large illustrated folder showing amazing prices paid. Vernon Baker, 1211-P.S.), Elyria, Ohio.

PATENT ATTORNEYS

INVENTORS: Take first step toward protecting your invention—without obligation. Write for "Free "Record of Invention" form for establishing date of invention, and Free "Patent Guide for the Inventor"—telling about confidential search service; how to sell inventions; convenient payment plan. Send for "Patent Guide" and "Record of Invention" form today. Clarence A. O'Brien and Harvey Jacobson, Registered Patent Attorneys, 22B-L Adams Building, Washington, D. C.

"INVENTOR'S Guide" free, containing 100 mechanical movements, information about patenting, selling inventions. Frank B. Ledermann, 154 Nassau St., New York.

PATENT Your Idea—New, useful ideas often very valuable. Two books—free—tell how to apply for patent protection—give six basic ways to sell your invention. Experienced patent counselors. Fees reasonable; deferred payments. Write today. Victor J. Evans & Co., 641-M Merlin Building, Washington, D. C.

INVENTORS: Before disclosing your invention to anyone send for Form "Evidence of Conception"; "Schedule of Government and Attorney's Fees" and instructions. Sent free. Lancaster, Allwine & Rommel, 413 Bowen Building, Washington, D. C.

INVENTORS: Send for free copy my 72-page book on patents. Reasonable terms. Prompt action. Confidential, personal service. L. F. Randolph, Dept. 340-A, Washington, D. C.

PATENTS—Booklet free. Highest references. Best results. Promptness assured. Watson E. Coleman, Patent Lawyer, 635 F Street, N.W., Washington, D. C.

"PATENT-Particulars" and Blanks, free, airmailed, Sterling Buck, P-Hotel Plaza, Washington, D. C.

PATENTS

INVENTORS: Foresighted manufacturers already planning post-war sale of new non-military products. If you have a useful invention, patented or unpatented, write Chartered Institute of American Inventors, Dept. 3-B, Washington, D. C.

PATENTS Wanted—Assignments quickly arranged if meritorious. Direct connections with large manufacturers. Listing forms free. Universal Guaranty Company, Box 772-S, Lancaster, Pa.

PERSONAL

DISCOVER your true self. Acquire mind power, attract success, companionship, through Ontology, science of reality. Gain health, happiness, confidence, independence. Ontology solves problems, overcomes obstacles, promotes security, explains Bible, answers prayer. Astounding revelations. Free booklet. Alexander Keene, D-10, Sedalia, Missouri.

TELEPATHY. "Human Radio" way to the accomplishment of all worthy desires. Personal application made to urgent needs. Don't wait for free booklet but send $1 now for five vital lessons (mailed weekly). Money back guarantee if not satisfied. Atlantean Telepathic Guild, Box 582B, Harrisburg, Pa.

THERE is a "Certain Way" of doing things that guarantee success one hundred percent. Few people know this, consequently, their success is largely a matter of chance. Write for free literature. Creative Thought Studio, P. O. Box 1, Greendale Station, Worcester, Mass.

HEALTH-Health-Health! If you suffer with any sickness, drop me a card. You'll receive informative literature Free, explaining the way to get well and keep well. Dr. Chirilis's Sanitarium-Clinic, 706 E. Jackson Blvd., Elkhart, Indiana.

PSORIASIS Sufferers: Pixacol, used only as directed, has brought relief when everything else failed. Applied externally, dries quickly, convenient. Try regular $1 bottle without investing a cent! Write: Pixacol Lab., Box 1298, Cleveland, Ohio.

EYE glasses by mail—Wear eye glasses for sixteen days; if not satisfied money will be refunded. Send no money; write for free catalogue today. Advance Spectacle Company, 537 S. Dearborn Street, Chicago, Dept. SP-11, Illinois.

NASAL Ailments—Use Bullock's discovery system and avoid a sinus operation. Write for descriptive literature, giving name of your druggist. Bullock's Laboratories, Alexandria, Va. Successors to National Laboratories.

WIN prize money: Booklet, "Successful Contesting", shows how—10c, postpaid. Bulletin listing $100,000.00 prizes included. World Publishing, 4515-L Cottage Grove, Chicago.

DEAFNESS. An amazingly successful Home Treatment. No hearing aids. No drugs. Small cost. Convincing literature. Duncan Institute, Ortega Station, Jacksonville, Florida.

LOVE, Business, Marriage problems confidentially answered. Send stamp, dollar & particulars. DeVore, Sta. B., Box 56, Los Angeles.

BEAUTIFUL oil paintings, 75c up. Dissell, 4667 Rockwood Road, Cleveland, Ohio.

RELIGIOUS Folders $1.25B. Names free. 710-5 St., Devils Lake, N. Dak.

SUPER strength quickly! Easy method. Information Free. 1036-17 Des Moines, Iowa.

SONGWRITERS, write for free booklet, Profit Sharing Plan. Allied Music, Dept. 68, 204 East Fourth, Cincinnati, Ohio.

LEARN Ventriloquism. 3c stamp brings particulars, Smith, Dept. 305, 801 Bigelow, Peoria, Illinois.

LOWEST prices blades, rubber sundries, personal needs. Free details. Star Products, Buffalo, N. Y.

HERBS—The proven blood cleansers, remove excess acids, mucus. Ask folder. Herb Center, 1334 F St., San Diego, Calif.

WOULD you like your eyesight improved and discard glasses? Send 25c for full instructions. L. F. Neer, Lake Worth, Fla.

VEGETARIANS: Send 10c for copy of only vegetarian newspaper in the world. E. L. Pratt, Pismo Beach, California.

POCKETBOOK Blessing for Prosperity. Send 10 cents. Rooney, 116 Prince Street, New York City.

HARD-OF-HEARING? "Audi-Tone" home treatment, $3.00. No More. National Mail Service 1504 Dodge, Omaha, Nebraska.

SAMPLE Magazine—Fashions, stories, poetry, 3c stamp. Anderson, Vineburg, California.

PHOTO FINISHING

TIE and wrap rolls securely. Do not mail in ordinary envelopes. Address plainly.

IMMEDIATE Service! Pictures returned same day order received. Sixteen guaranteed deckled-edge Velox prints from roll, 25c. One colored or two plain enlargements plus 8 deckled-edge Velox prints, 25c. Free! Coupon for 8x10 enlargement Free with each 25c order. Any 36 exposure 35mm film fine-grain developed. "Magic-Eye" timed, vaporated and each good negative enlarged to 3x4 on deckled-edge Velox paper, $1.00. 18-exposure, 60c! Reloads: 36 exposure, 50c; 18 exposure, 35c. 3x4 deckled-edge reprints, 3c each. Write for Free mailers. Free premium offers. American Studios, Dept. 407, LaCrosse, Wisc.

35mm, ARGUS, Leica, etc., (except "Mercury") 36 exposure rolls, fine grain developed (Eastman DR-20) and beautifully enlarged to 2" x 4" glossy prints, 90c. Cartridge reloaded with Eastman Plus X, 35c. 18 exposure rolls, 55c, reload 20c. Films permanently protected by revolutionary Cryolyte Process. 24-hour service. Satisfaction guaranteed. Free mailing bags, sample print. Photo Contest! Valuable Prizes! Write Technifinish Laboratory, 641-645 Brown St., Dept. 647, Rochester, N. Y.

CUSTOM Finishing—36 exposures developed to 2¼x4¼ prints, $1.00; 18 exposures developed to 3¼x4½ prints, $.75. 828, 127, 620, 120 developed and double size prints $.25. 616, 116, developed and double size prints, $.30. Split rolls, $.45. Write for complete services. Village Film Laboratories, Box N4046, Village Station, Los Angeles, California.

DOUBLESIZE Prints. Your roll developed and 8 doublesize prints 25c; from 116 or 120 size negative you receive 4x6 inch prints. All other size negatives printed in proportion. 16 exposure rolls 50c; 12 exposure rolls 35c. Reprints 3c each. "Our Guarantee." Everlasting Hi-gloss Finish. Overnight Service. Pacific Photo Service, Box 666, San Francisco, California.

BIGGEST $1.00 value in 35MM finishing today. 36 exposure fine grain 3½x4½ enlargements; deckled, embossed margin and date. Eighteen exposures 75c; sixteen exposure splits 55c. Free mailers. 8 exposure rolls in beautiful, deckled contact finish with embossed wide margin. 25c. Mailbag Film Service, Box 5440A, Chicago.

FINER Finishing Specials 25c. Eight exposure rolls developed, with two prints of each or one enlarged print of each negative. Genuine nationally known Moentone Enamel Finish. Superior quality since 1898. Moen Photo Service, 209 Moen Bldg., La Crosse, Wisconsin.

REPRINTS 2c each, 100—$1.50. 6 or 8 exposure rolls developed 2 prints each exposure 25c. 36 exposure 35mm. rolls fine grain enlarged prints $1.00. Mailing bags Free. Mercury, B-109 North Dearborn, Chicago.

SELL Your Pictures. Write for details & free market letter. Free-Lance Photographers Guild, Inc., 219 E. 44th St., Dept. 11S, New York, N. Y.

16 OVERSIZE Deckledged prints and two enlargements, 25c, Owlphoto P82, Weatherford, Okla.

PHOTOGRAPHY for pleasure and profit. Prepare at home. Common school education sufficient. Write for information and requirements. American School of Photography, 1315 Michigan, Dept. 1726, Chicago.

TWO fine bromide enlargements with 8 Finerfoto Prints from all 8-exposure rolls developed only 25c. These beautiful enlargements make splendid gifts. Finerfotos, Box 898-18, Minneapolis, Minn.

ROLLS developed and 4x6 oversize glossy Velox prints 8 exposure 30c, 12 exposure 45c, 16 exposure 60c. Overnight service. Clemet Photo Service, 1318 W. Columbia Ave., Philadelphia, Pa.

ROLLS Developed—25c coin. Two 5 x 7 Double Weight Professional Enlargements, 8 Gloss Deckle Edge Prints. Club Photo Service, Dept. 21, LaCrosse, Wis.

ROLL developed, eight snappy 4x6 enlargements, or sixteen sparkling prints 25c. Crystal Studios, Box S-159, Rushford, Minnesota.

POULTRY & SUPPLIES

POULTRY Profit-Making. Monthly tips on raising, laying, feeding. New ideas. Get America's leading poultry magazine. One year 25c; five years $1. Poultry Tribune, Dept. 23, Mount Morris, Ill.

MAKE poultry profits the American Way. Monthly helps and suggestions cost less than 3c. One idea may net many dollars. Only 25c year, coin or stamps. American Poultry Journal, 528 S. Clark, Chicago.

PRINTING, MULTIGRAPHING, MIMEOGRAPHING, LABELS

POPULAR Science readers need and buy all kinds of printing. Advertise your offers in this column for extra business. Rate 35c a word. Classified Section, Popular Science Monthly, 353 Fourth Avenue, New York City.

INDIVIDUALLY Designed Letterheads, $2.95 thousand delivered. Anything quoted. Irelan Printing Co., 2427 Oakland, Dayton, Ohio.

5000 LOTS—Elegant Envelope Slips, $3.75; 6 x 9 Circulars, $8.25; Postcards, $3.75. All Printing Low Prices. Samples. Goodprint, Harrisonburg, Va.

EMBOSSED, white bond, 8½ x 11" letterheads. Ink—blue, black 500—$1.00 with order, balance $2.70 C.O.D. Goheso, FS6, Omena, Michigan.

HAMMERMILL letterheads, envelopes, any color, 39 type styles. Free particulars. Woodruff's, 217-D4 Lewis, Duluth, Minnesota.

250 DISTINCTIVE Bond letterheads or envelopes printed, $1.50 postpaid. Lumco, Kimball, Nebraska

LETTERHEADS, envelopes, 100 each—$1.00. American, Box 391, Charlotte, N.C.

JOB Printing. Quick, reasonable. Samples. Atlantic, Box 653-B, Rock Hill, S. C.

JOB printing, circulars, letterheads, envelopes. Bell Press, PS, Winton, Pa.

PRINTING OUTFITS & SUPPLIES

PRINT your own cards, stationery, circulars, advertising. Save money. Simple rules furnished. Print for others, nice profit. Junior outfit $8.25; Senior outfits $17.38. Details free. Kelsey, Inc., T-8, Meriden, Conn.

PRINT at home. 10c will bring a complete catalog of presses, type and supplies. P. Peiffer & Company, 4 Columbia St., Newark, N. J.

INEXPENSIVE 6x9 Printing Press. Details Free. Novelty Shop, Downsville, La.

PRINTING Presses, Type, Supplies. Lists 3c. Turnbaugh Service, Loysville, Pa.

NEW Type 39c Font. Catalog dime. Box 123F, Jackson, Mich.

PROFITABLE OCCUPATIONS

MECHANICALLY Inclined Men—Own and operate general Appliance Repair shop. Complete, illustrated course shows you how. Welding, Refrigeration, Motor repair. How to get business, etc., all phases covered. Free literature. Christy Supply, Dept. 1022, 2835 N. Central Ave., Chicago.

$5000 FROM Half Acre! Growing Ginseng. Seed, contract supplied. Particulars 10c. Associated Growers, Dept. 12, St. Norbert, Manitoba.

$40.00 WEEKLY. Made growing mushrooms. Fresh, Dried. Dominion Patent 331583, free spawn. North American, 169Y Yonge, Toronto, Canada.

MONEY raising rabbits. Investigate; folder 10c. Close's Rabbitry, Tiffin, Ohio.

RAISE Guinea Pigs; make money. War demand great. Free details telling how. Research Co., 2436 W. York St., Philadelphia, Pa.

RADIOS, SUPPLIES & INSTRUCTION

BRAND New Radio Book! Build and repair your own portable, F-M receiver, radio-phonograph or short-wave set with help of Everybody's Radio Manual. 256 pages. Only $1.00! Dept. C-112, Popular Science, 353 Fourth Ave., New York.

RADIO Service men and experimenters send for our giant radio catalogue. Save dollars. United Radio Co. (1000M), Newark, N. J.

REVISED plans 18 Crystal Sets (SW record 5300 miles), with "Radiobuilder"—year, 25c. Laboratories, 1406-T 77th Avenue, Oakland, Calif.

RADIO kits—ready to wire. Factory quality. All kinds. Latest catalog—free. McGee Radio, PS-20, Kansas City, Mo.

MAKE your own simple long distance Crystal radio. Illustrated instructions, 25c. Alva Allen, PS427, Clinton, Missouri.

RARE COINS

FREE! Foreign Coin, banknote and large 50-page illustrated coin catalogue to approval service applicants. Send 3c postage. Up to $20 cash paid for Indian head cents. All dates wanted. Buying list 10c. Tatham Coinco, Springfield-D50, Mass.

WE buy Indian Cents, Lincoln Cents, Old Money. Send 10c today for 1942 catalogue of prices. We pay for all wanted U. S. Coins. American Rare Coin Co., Dept. 4, Transportation Bldg., Chicago.

COMMEMORATIVE $1/2s, Columbian, Lincoln, Stone - Mountain, Long - Island, Cleveland, $1.00 each. Illustrated catalogue 25c, Norm Shultz, Salt Lake, Utah.

WILL pay to $350.00 for certain dimes. Nickels $500.00. Cents $800.00. Over 1000 quotations. Catalogue 10c. Allan Appell, Sedalia-6A, Missouri.

BUYING, selling lists U. S. coins, stamps, 3c. Large catalogue coins, currency, supplies, 8c. Bebee Coinco, 1180 East 63rd, Chicago.

WILL Pay $5.00 each for certain Lincoln Pennies! Indianheads $50.00; Dimes $1,000.00. Catalogue 10c. Federal Coin Exchange, 10-PS, Columbus, Ohio.

10 INDIAN Head cents, different dates, also pricelists, 35c. Schultz, 1053¾ Richwood, Cincinnati, Ohio.

WE purchase all Indianhead pennies. Complete catalogue 10c, Waltman, 398 Broadway, New York.

30 DIFFERENT Indian cents $1.50. Sales list free. Wittlin, 1681 Broadway, N.Y.C.

RUBBER STAMPS

ONE line 15c; two lines 25c; three lines 35c. Excello, Box 500, Shreveport, Louisiana.

3 LINES 30c; Cushioned, indexed, 35c; Signatures, $1.50. Printrite, Wauwatosa, Wis.

CUSHIONED, 2 lines 25c, 3—35c. Ours are better! Ad-Crafts, LaCrosse, Wis.

SONGWRITERS

LYRIC Writers: We need words for three melodies already contracted for publication. If you can write them, contact us immediately. National Music Agency, Dept. B, Box 768, Hollywood, Calif.

WANTED, Poems, to be set to music. Submit for consideration. Transcription records made. Rhyming Pamphlet Free. Keenan's Studio, PS, Box 2140, Bridgeport, Conn.

SONGWRITERS—Send Poem For Immediate Consideration and Free Rhyming Dictionary. Richard Brothers, 146 Woods Building, Chicago.

SONG poems wanted for musical setting. Submit poem for immediate consideration. Five Star Music Masters, 646 Beacon Building, Boston.

SONGWRITERS: Send poems for offer and Free Rhyming Dictionary. Phonograph records made. Vanderbilt Studios, Box 112-EC, Coney Island, N. Y.

SONGWRITERS: We offer complete service. Melody writing, recording, radio broadcast, marketing. Screenland Recorders, 1501D Vine St., Hollywood, Calif.

SONGWRITERS—Want a tune that really fits your words? I can guarantee satisfaction! How? Inquire—Songwriters' Professional Service, Box 62, Shamokin, Pa.

SONGS—Song poems wanted. No charge for melodies. Marketing Service, Hollywood Recording Studios, 87L23 Preuss Sta., Los Angeles.

SONGWRITERS—Write today for free explanatory booklet, plan. Song Service, 331-J West 46th, New York.

ORIGINAL music composed to your words. Reginald Belcher, Chatham, N. J. Established 1910.

SONGWRITERS: Write for free instructive booklet concerning song poems, United Music, Dept. 26, Salem, Ind.

SONGWRITERS, composers, free information about marketing your songs. Aaba, 138 West 81st Street, New York.

SONGWRITERS: Write for free booklet, Profit Sharing Plan. Allied Music Company, 204 East Fourth, Cincinnati, Ohio.

SONGWRITERS! Special offer: Send your poems to Siebeneck Music Co., Kalida, Ohio.

SONGWRITERS! Outstanding, amazing offer. Hibbeler, C15, 2157 No. Avers, Chicago.

SPORTING GOODS, GUNS, FISHING TACKLE, ARCHERY

SEND for free illustrated catalog of Lawrence leather belts, holsters, gun cases and other sporting equipment. George Lawrence Company, Portland, Oregon.

BOWS—Arrows: Construction-Instruction Book 50c. Catalog free. Archery, 617 South State, Chicago.

STEER Hunting Blowing Horns High Tone, 12", $1.50; 18", $3.00. General Mercantile Co., Laredo, Texas.

ARCHERY equipment: catalogue free. Mid-West Archery, 2209-D East 75th, Chicago.

USED guns, bought, sold, exchanged. List stamp. Howe, Coopers Mills, Maine.

STAMP COLLECTING

NOTICE—Readers answering ads offering Approvals receive a selection of stamps from which they may make purchases at prices indicated. Ten days are allowed for payment and return of undesired stamps. Otherwise approval applicants become subject to Section 2350, Postal Laws & Regulations, 1932, providing penalties for obtaining property by false pretense.

WOW! $10.00 Worth of Fun for only 10c! 500 Foreign Stamps, unsorted and unpicked (mostly on bits of paper) just as received from the church missions and other sources. Africa, So. America, Australia, China, Philippines, Dutch Indies, and other countries are represented. Includes a few commemoratives, airmails, and stamps cataloging up to 25c or more each! The biggest Package of Fun in Stampdom—and you might find something really valuable! Price only 10c to serious approval applicants! Money back if not delighted. Jamestown Stamp Co., Dept. No. 5, Jamestown, New York.

GIANT Packet 136 All Different from Africa, South America, South Sea Islands, etc. Includes Nicaragua airmail, two scarce unused United States cataloging 20c, triangle and animal stamps; many others. Also includes fine collection 25 different British Colonies—Charkari, Jamaica, Johore, etc. and United States $4 and $5 high values. Total catalog price over $4.00! Everything for only 5c to approval applicants! Mystic Stamp Co., Dept. 55-A, Camden, New York.

FREE—F. D. Roosevelt complete Mint Brazilian Pan-American Union set picturing our Commander-in-Chief, Vargas and Map of Americas with 114 different up-to-date Values from: South America, our good neighbors, United Nations, Heroic Russia and War-torn Europe in Commemoratives, Pictorials, Air-post and New Issues—cataloging $2.54 to new approval applicants only 10c! Intercity Co., Dept. Y, Port Washington, N. Y.

POSITIVELY Greatest Free offer—Latest Scott's International $4.00 Stamp Album—covering entire World, contains 36,000 illustrated, descriptive spaces; Scott's 1942 Standard $3.50 Catalogue "Philately's Encyclopedia"—absolutely Free to applicants for Foreign Approvals becoming customers. Bargain Stamp Service, Palm Springs, California.

VICTORY Packet Free: Includes stamps from Tanganyika—British Cayman Islands — Animal — Scarce Babyhead — Coronation — Early Victorian — Airmail—Map Stamps—with Big Catalogue—all free—send 5c for postage. Gray Stamp Company, Dept. PR, Toronto, Canada.

FREE—Your choice of any 10 stamps from our first U. S. Approval selections, plus illustrated 1942 U. S. Price, Check list. This generous offer made to introduce one of the finest selections of U. S. Approvals ever offered. Cosmopolitan Stamp Co., Dept. S, 1457 Broadway, New York.

$1.00 (Cat. Price) for 1c! Two mint U.S.A., cat. 20c; "queer countries" packet (Djibouti, Manchuria, etc.); scarce set Russia, cat. 75c. Everything for only one cent to approval applicants! Garcelon Stamp Company, Box 418, Calais, Maine.

19TH CENTURY U. S. Commems., Civil War Revenues, Battleship $5 & $10 Stamps, 1942 Illustrated U. S. Catalogue. Free to U. S. Approval Applicants. Metropolitan Stamps, 198-X Broadway, New York.

SMOKY Mountain commemorative sheet, largest U. S. stamp issued, and 33 U. S. including commemoratives, airmail, revenues, etc. Catalogs 75c—To approval applicants for 5c. Curhan Stamp Company Dept. C, Gloucester, Mass.

SEYCHELLES, Nejd, Caymans, Manchukuo, Brunei, Turks Caicos, British Solomons (Cannibaland). Everything 3c with approvals. Viking, 130-P Clinton St., Brooklyn, N. Y.

FINE Approvals, freshly mounted. Fast, personal service. Tell me what countries you prefer and I'll send their stamps. Milton Skinner, 345 East Ocean, Long Beach, Calif.

206 DIFFERENT stamps including Kedah, Haiti, Cochin, Albania, Johore, Perak, only 10c to approval applicants. Reich Stamp Co., 4647 Kenmore, Chicago, Dept. S3.

BRITISH Empire Collection! Burma, Cyprus, Gwalior, Sarawak, Tasmania; Also 50 other British. Only 5c with Pictorial, and Commemorative Approvals. Lyman, 97 Nassau, New York City.

SOUTH and Central America One and two cent approvals. Hundreds different. Commemoratives, Pictorials and airmails. Scotty Stamp Co., 627 W. 239th St., New York, N. Y.

IMPORTS now prohibited, while they last —20 different India, including pictorials, 5c with approvals. Dunn, Box 30-S2, Royal Oak, Michigan.

STAMP Dealers—Your ad in this column will produce profitable business at low cost. Write for proof. O. K. Kelly, Dept. S-1, 353 Fourth Ave., New York, N. Y.

FREE! Complete "United States" stamp catalog with 1,000 illustrations! Send 3c for postage. Harris & Co., 99 Transit Building, Boston, Mass.

U.S. $5.00 Stamp No. 573 (Perforated Initialed) 10c to applicants for U.S. approvals. M. B. Haycock, 61 O'Brien Place, Brooklyn, N. Y.

BURMA. Rare bargain you can show friends with pride; 6 different 5c with approvals. Stamp Tongs free. Kendall, Box 251, Gardner, Mass.

UNITED States approvals complete coverage fine quality, attractive prices. Seminole Stamps, Box 436, Coconut Grove, Florida.

WANTED—U. S. Postage any amount, any denomination. Also accumulations. Magic Novelty, 1039 Washington, Miami Beach, Fla.

SPECIAL—Airmails—23 different, including Zeppelin, Triangles, Latin-America, etc., 5c with approvals. Continental Stamp Co., Dept. C, Sandy Hook, Conn.

UNPICKED! 100 U. S. revenues on documents—10c! (700—50c). Excellent mission mixture: pound—40c! (10 pounds—$3.00) Vanvoorhels, Hyndman, Pa.

20 RUSSIA (Soldiers, commemoratives, etc.) Free. Approvals. Dominion Stamps, Arlington, Va.

LOWEST United States stamp prices. Free Illustrated catalogue. Creevey, Berwick, Pa.

MEXICO Census Commemorative Set, Free with approvals. Pladon Stamps, 1717-S Idaho, Toledo, Ohio.

ABYSSINIA, No. 133, catalogues $1.25, 15c with approvals, Alvin Fensterheim, 353 Fort Washington Avenue, New York City.

THICK Packet stamps with odd shapes, 10c. Approvals. Kellerman, R. R. 10, Sta. M, Box 476, Cincinnati, Ohio.

25 DIFFERENT Asiatic stamps free. Quality penny approvals included. Harding Stamp Plan, 5031-N, Harding, Chicago, Ill.

20 COMMEMORATIVES 5c with approvals. Elm Stamp Company, Dept. B, E. Providence, R. I.

30,000 COLLECTION, owner enlisted. Wants filled below market. Florida Stamp Club, Titusville, Florida

SIX Liberia Airmail Triangles, complete set, 5c with approvals, Lorain Brown, Marion, Michigan.

15 DIFFERENT Newfoundland 5c, 20 different 10c. Stamphouse, 1525 West 11th, Brooklyn, N. Y.

FREE!!! Russia War set, Postage 3c. Williams, 601 Archerbldg., Baycity, Michigan.

FREE! Pony Express set (facsimiles). Postage 3c. Roberts, 401 Shearerbldg., Baycity, Mich.

FREE! Western Hemisphere Packet. Postage 3c. Owens, 801 Welshbldg., Baycity, Mich.

INTERESTING Mixtures. Pound U. S. $1.15; foreign $1.40. Hermes Stamp Company, Drawer 276, Hempstead, N. Y.

FREE Packet—U. S. Commemoratives, Triangle, Airmails, 50 others. Approvals. F-S Company, Box 2154, Houston, Texas.

FREE! Stamp wallet, sincere approval buyers. Thiese, 10526 Anzac, Los Angeles, Calif.

SELL stamps. Wholesale outfit, $44.75. Retail for $10.00. Sets, singles, accessories. Ellis, 55-S Reade Street, New York.

1000 MIXED United States, 18c. Two pounds, $1.00. Prospect Stamp Company, 2758 Cruger Avenue, New York City.

TEN crazy-shaped stamps, 3c with approvals. O. Knopp, Box 1381, Bristol, Conn.

NEWFOUNDLAND—20 different, 5c. Approvals. Neumann & Co., 6728 W. Finger Place, Milwaukee, Wis.

117 DIFFERENT stamps with approvals, 5c. Libby Stamp Company, Box 43-S, Station P, Brooklyn.

15,000 VARIETIES 1c, 2c, each! Davison, Box 31B, Wollaston, Mass.

77—LIBYA, Guatemala, Manchukuo, Costa Rica, Greece, Mozambique, Etc., 5c. Lufbery, Middletown, Connecticut.

EXCHANGE your duplicate stamps. List, swappers, dime. Registrar, Box 2166, Denver, Colorado.

U. S. COMMEMORATIVES—80 different, 25c. Crystal Stamp Co., Racine, Wisconsin.

1000 MIXED U. S. old and new, 25c. Weatherby, Troy, Ohio.

FREE premiums with approvals. Baison Stamps, 2816 W. 36th, Brooklyn, N. Y.

U. S. PARKS Complete 12c—Better Grade Approvals. Box 488A, Minneapolis.

APPROVALS—Large selections. Low prices. Box 675, Charlotte, North Carolina.

U. S. $5.00 (No. 573) 25c with approvals. Ruthandale, 569 Staples, San Francisco.

PACKET Old Civil War Stamps 25c. Buckey, Ludlow Bldg., Dayton, Ohio.

FREE Premium with approvals. Vargo Stamps, 1423 Cleveland, Racine, Wis.

PENNY approvals! Dandy packet free. Monjar, 1750 Fairmount, Cincinnati, Ohio.

PENNY Approvals that satisfy. Neil Gronberg, Box 5441S, Philadelphia, Penn.

STAMP cat. $3.00 free. Approvals. R. Augsburger, 432 W. Maumee, Adrian, Mich.

1000 STAMPS, prize packet—25c. Nagle Stamp Shop, North Judson, Indiana.

5000 MIXED U. S. postage, $1.00. Max Kaye, Beaumont, Springfield, Mass.

OUTSTANDING U. S. values. Free list. Ewing, 109 North Dearborn, Chicago.

FIFTY different Brazil—10c. Approvals sent. Prall, Hackettstown, New Jersey.

PENNY approvals that please. McKee, 1217 Scott St., Covington, Ky.

1000 U. S. 10c PLUS 4c postage. Jem Stamps, Port Jefferson, N. Y.

TRAPPERS

TRAP Fox or Coyote: Bare ground and deep snow trapping. Free illustrated circular. Q. Bunch, Welch, Minn.

TREASURE FINDERS

MT-SCOPE Metal Locator fully guaranteed and unsurpassed in efficiency. Time payment plan, trade-in and accessories. Free literature. Fisher Research Laboratory, Palo Alto, Calif.

SEEK Buried Treasure. Methods, devices and mysteries explained. Descriptive circulars free. D. Century, Box 151, Glen Ellyn, Ill.

TYPEWRITERS, OFFICE DEVICES

$4.00 INVESTMENT earns $9.00. Sell quality typewriter ribbons, carbon paper to offices. Duplico Mfg., Dept. S1, Far Rockaway, N. Y.

WANTED—MISCELLANEOUS

HIGHEST Prices for used Cameras, Binoculars, Microscopes, Drawing Sets, Tools, any optical or scientific Instrument. Satisfaction guaranteed. Gordon's, 162-S Madison, Chicago.

MERCURY (quicksilver) High Speed Tool Steel scrap—Special alloys—Metallic Byproducts. Metallurgical Products Co., 35th & Moore Sts., Phila., Pa.

MERCURY (Quicksilver) $1.25 to $1.50, per pound, no less. Any condition. Western Metal Co., Bloomington, Illinois.

WATCHES

WATCHMAKERS' Materials—Tools—Watches. Bought: Sold. Best prices for Old Gold, diamonds. Free Catalog. Ben Segal Company, Box 150, Chicago.

WELDING, SOLDERING

BUILD d.c. arcwelder without rewinding armature. Plans $1.00 each. 25 to 600 amperes from Vehicle motors. Light plant generators. Automobile starter-generators. Welders Club, WB-3432 M-Mart, Chicago.

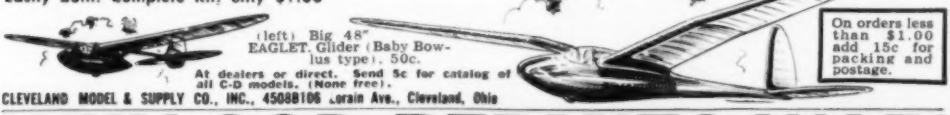
MAKE your own electric welder. Complete kit. Everything supplied with full directions for assembly. $5.95. Will make a $19.95 set. Marvel Electro Welder Mfg. Co., 195-B Centre St., New York City.

USE gasoline for welding and cutting. Make your own torch. Instructions $1.00. U. S. currency. Matthews Mfg. Co., Red Deer, Alberta, Canada.

BUILD THE BIGGEST $1.00 PLANE IN THE U. S. —*Giant 7-Foot Glider*

Famous CLEVELAND CONDOR. Soars for hours.

Easily built. Complete Kit, only $1.00



(left) Big 48" EAGLET. Glider (Baby Bowlus type). 50c.

At dealers or direct. Send 5c for catalog of all C-D models. (None free).

On orders less than $1.00 add 15c for packing and postage.

CLEVELAND MODEL & SUPPLY CO., INC., 4508B106 Lorain Ave., Cleveland, Ohio

WHY GOD PERMITS WAR!

Why does God permit war? Why does He permit cruelty, injustice, pain, starvation, sickness and death?

Thirty years ago, in Forbidden Tibet, behind the highest mountains in the world, a young Englishman named Edwin J. Dingle found the answers to these questions. A great mystic opened his eyes. A great change came over him. He realized the strange Power that Knowledge gives.

That Power, he says, can transform the life of anyone. Questions, whatever they are, can be answered. The problems of health, death, poverty and wrong, can be solved.

In his own case, he was brought back to splendid health. He acquired wealth, too, as well as world-wide professional recognition. Thirty years ago, he was sick as a man could be and live. Once his coffin was bought. Years of almost continuous tropical fevers, broken bones, near blindness, privation and danger had made a human wreck of him, physically and mentally.

He was about to be sent back to England to die, when a strange message came—"They are waiting for you in Tibet." He wants to tell the whole world what he learned there, under the guidance of the greatest mystic he ever encountered during his twenty-one years in the Far East. He wants everyone to experience the greater health and the Power, which there came to him.

Within ten years, he was able to retire to this country with a fortune. He had been honored by fellowships in the World's leading Geographical Societies, for his work as a geographer. And today, 30 years later, he is still so athletic, capable of so much work, so young in appearance, it is hard to believe he has lived so long.

As a first step in their progress toward the Power that Knowledge gives, Mr. Dingle wants to send the readers of this notice a 9,000-word treatise. It is free. For your free copy, send your name and address to the Institute of Mentalphysics, 213 South Hobart Blvd., Dept. A202, Los Angeles, Calif. Write promptly.

ANY BIG BOOK ON THIS PAGE

ONLY $1.00

Take Your Choice of these SMASHING BARGAINS!

Everybody's Radio Manual—Brand new! How to build and repair home radios, F-M receivers, portables, radio-phonographs, short wave sets, wireless record players, home recorders, etc. Written in simple language with hundreds of diagrams that make every step easy to follow. 256 pages. Cloth bound. **Only $1.00!**

Tinkering With Tools—Save up to 50% by doing your own home repairs! Shows how to do carpentry, plastering, plumbing, painting, electric wiring, masonry, joining, shingling, glazing, patching, etc. How to select, use and care for tools. 215 illustrations. 260 pages. Cloth bound. **Only $1.00!**

The Home Chemist—Shows how to set up an inexpensive laboratory with low-cost apparatus! How to experiment with gases, metals, colloids, etc., how to baffle your friends with chemical stunts and magic, how to perform experiments in physical and electrochemistry! 131 illustrations. 192 pages. Cloth bound. **Only $1.00!**

Woodworker's Turning and Joining Manual—Everything you need to know to turn out articles that are really professional! How to make joints and cuts, bore and mortise, apply fillers, stains and finishes, how to inlay and veneer, etc. 236 illustrations. 192 pages. Cloth bound. **Only $1.00!**

Wonders Through the Microscope—Hundreds of experiments you can do with *any* microscope! How to secure specimens of plant life, insects, bacteria, water animals, crystals, etc. How to build low-cost apparatus and make photomicrographs. 118 illustrations. 192 pages. Cloth bound. **Only $1.00!**

Ship Model Making—All the secrets and shortcuts of real craftsmen! How to shape hulls, how to make rigging, sails, deadeyes, blocks and fittings, how to cast small metal parts, how to decorate and mount, etc. Plans for Galleon, Clipper Ship and Racing Yacht. 162 illustrations. 192 pages. Cloth bound. **Only $1.00!**

QUANTITIES LIMITED! MAIL COUPON NOW!

SEND NO MONEY NOW!

POPULAR SCIENCE—Dept. 112
353 Fourth Ave., New York, N. Y.

Send me the book(s) circled below. ☐ I enclose $_____. ☐ I will pay postman $1.00 each, plus postage. You guarantee satisfaction or money cheerfully refunded.

Radio *Tinkering* *Chemist*
Woodworker's *Microscope* *Ship Models*

Name_____

Address_____

City_____ State_____

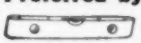
READY CASH
HOT POTATO CHIPS

Has the war wiped out your business? Are you about to lose your job on account of the war? Here's a booming business. Potato chip sales and profits are reaching an all-time high. Potato chip producers are rushed to the limit. Food sales are skyrocketing. Shortage of sugar boosts potato chip sales. Stores frantic for merchandise to sell do your retailing for you. Plenty of good, vacant stores near center of almost every town, village or city. You can start in store or own home. We still have a few complete famous Long Eakins Potato Chip Outfits ready for immediate shipment. No previous experience required. Follow simple instructions we furnish. We have cash or credit terms. Plenty of bags, advertising helps, etc.

FREE—Complete details how to get into potato chip business. Rush name.

LONG EAKINS CO., 1147-S High St., Springfield, Ohio

EMPIRE LEVELS
Preferred by MASTER CRAFTSMEN . . .



EMPIRE TORPEDO LEVEL . . . Smallest and Handiest Accurate Level made. "Cigar-shaped", no sharp corners to tear pocket. Walnut stock. Has Level, Plumb and 45° vials. 9" long, only 2 oz. No. 44 . . . $1.10. Order from local dealer. Write for literature.

EMPIRE LEVEL MFG. CO., Dept. S-2, 717 S. Sixth St., Milwaukee, Wis.

ACE
LATHE TOOL SET

$14.50

Be permanently tooled-up for *every* operation on your Metal Cutting Lathe

The ACE Set is complete—there's nothing more to buy. Drop forged by the manufacturers of cutting tools used by 90 per cent of the plants and shops in industry they are correctly designed, are of special steel, are finely finished, are stronger—will last a lifetime. You can cut easier, faster and more accurately with ACE TOOLS.

At your Hardware Store—Circular FREE.

ARMSTRONG BROS. TOOL CO.
"The Tool Holder People"
329 N. Francisco Ave., CHICAGO, U.S.A.

Now $9.95 Only

REAL ENGINE VALUE

The G. H. Q. is a miniature gasoline engine that really operates. Over 15,000 sold in the last year. Now is your chance to buy the *New Improved* 1943 model for $9.95. ABSOLUTELY COMPLETE with coil, condenser, plug, instructions, etc. Fully bench tested and ready to run. For boats, planes, midget cars, etc. Send only $1—*Shipped Collect C.O.D. same day. Send 1c for Free circular or 6c for Jumbo catalog of hundreds of plane, boat and hobby items.*

GHQ MOTORS, Dept. S, 40 East 21 St., New York, N.Y.

When Writing Advertisers
Please Mention POPULAR SCIENCE

12 WEEKS SHOP TRAINING

TRAIN FOR YOUR PLACE IN ELECTRICITY
I'll Finance Your Training

EXTRA 4 WEEKS COURSE IN RADIO INCLUDED

Electricity is the mighty power behind our Victory Program. Trained Electrical men are needed. PREPARE FOR YOUR PLACE this amazingly easy way. "Learn by Doing". READ EVERY WORD OF MY MESSAGE.

HOW YOU CAN BEST SERVE YOUR COUNTRY IN WAR AND PEACE

IF YOU'RE DRAFTED. Trained Electricians are eligible to apply for higher Army ratings. **IF YOU'RE DEFERRED. Everyone** with proper training can serve in war industry. **AFTER THE WAR.** Skilled Electricians who get their training now should be **vitally needed** for good-pay Peace-time jobs.

"LEARN BY DOING"—90 DAYS

Coyne training is EASY, PRACTICAL! No dull books. No reciting. Don't let lack of money stop you. Get training first—then pay for it in easy monthly payments after you graduate. If you need part-time work to help out with living expenses, I'll help you get it. This school is 43 years old. Mail the coupon for my big, FREE Coyne book. Act at once.

H. C. Lewis

H. C. LEWIS, President
COYNE ELECTRICAL SCHOOL
500 S. Paulina St., Dept. 82-73, Chicago, Ill.

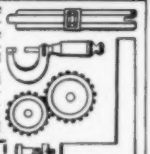
Send me your **Free Book** and **tell me about your plans to help me.**

NAME.....

ADDRESS.....

CITY STATE

Short-Cut Mathematics
COMBINED WITH
Practical Mechanics Simplified



NEW 2-in-1 reading course! Now you can learn the speedy, simplified system of calculation used by draftsmen, engineers, accountants, "master minds" on the stage. Learn easy way to multiply 4 figures by 4 figures without using old-fashioned multiplication; add long columns of figures this lightning short-cut method. Learn horsepower, slide rule, micrometer, logarithms, wood measure, puzzles, etc., etc. Large illustrated volume complete with answers, only $1 postpaid. Satisfaction or refund. Amaze friends with your magic-like mental answers.

FREE Complete details . . . mail coupon TODAY!

NELSON CO., 500 Sherman St., Dept. L-384, Chicago
Please send free details about "Short-Cut Mathematics and Practical Mechanics Simplified." No obligation.

Name.....

Address.....

Answers your every welding question

516 Pages; 512 Illustrations

Get this big volume packed full of sound advice with detailed diagrams and charts. Get expert training at

The HOBART Trade School ONE OF AMERICA'S FINEST!

Only $2.00 POSTPAID

Easy to Read and Understand ARC WELDING
Manual and Ready-Reference Text

Most Complete, Concise and Authoritative Book on Arc Welding ever published

5 DAYS Inspection FREE!

USE THIS Coupon TO ORDER ACT NOW!

A Daily Guide for Today's War Work. You'll use it constantly to help improve your weld quality, speed and efficiency.

Latest Techniques, Methods, Procedures ... explained and illustrated. You'll be a top-notch operator holding down the big-pay war jobs!

HOBART trained in a valuable post-war trade. *"One of the World's Largest Builders of Arc Welders"*

HOBART BROS. CO., Box P-112, TROY, OHIO

Send _____ copies of "Practical Arc Welding" @ $2.00 ea. ☐ C.O.D. ☐ Check enclosed.
Send information on ☐ Welders ☐ Trade School

NAME_____

ADDRESS_____

★ Five of the first fifty-three Army-Navy Production Award pennants . . . for plants with the highest achievement in the production of war equipment . . . have been awarded to Westinghouse.

To Westinghouse men and women, for "an outstanding contribution to victory"

IN ANNOUNCING that five of the first fifty-three Army-Navy Production Awards go to Westinghouse, James Forrestal, Undersecretary of the Navy, said, "The men and women in these plants are making an outstanding contribution to victory. Their practical patriotism stands as an example to all Americans and they have reason to be proud of the record they have set."

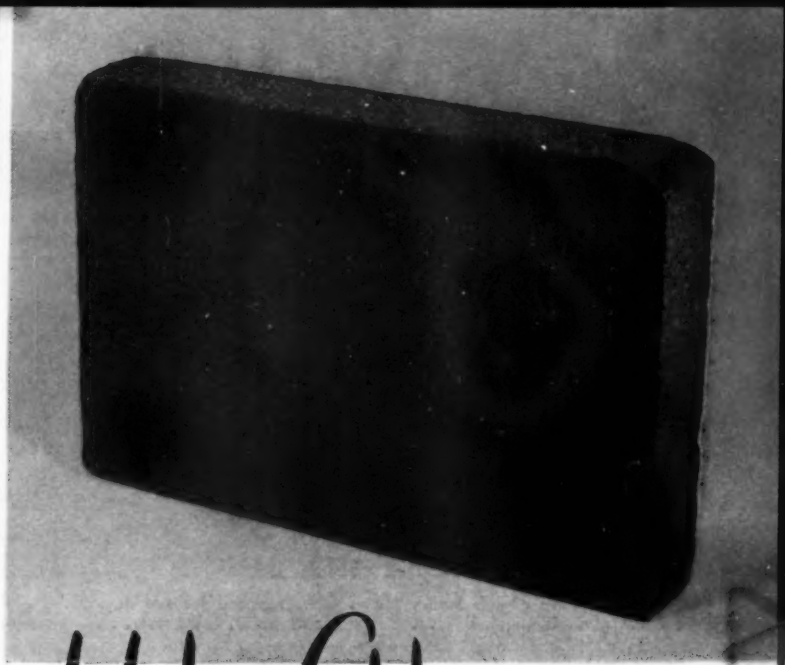
Westinghouse, one of the world's leading manufacturers of electrical equipment, is now producing war materials at the rate of 4000 carloads per month . . . enough to fill a freight train *37 miles long every 30 days.*

To this effort, we are applying the full extent of Westinghouse "know how" in scientific research, in engineering, and in production. As a result, production, on a man-hour basis, is 95% ahead of the mid-1940 rate. In some divisions, production is up more than 300%.

This is the record to date. We hope to make it still better tomorrow.

Westinghouse

Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. • Plants in 25 cities—Offices Everywhere



Foam of real glass, hardened and formed into building blocks like this, provides heat insulation for many industrial uses

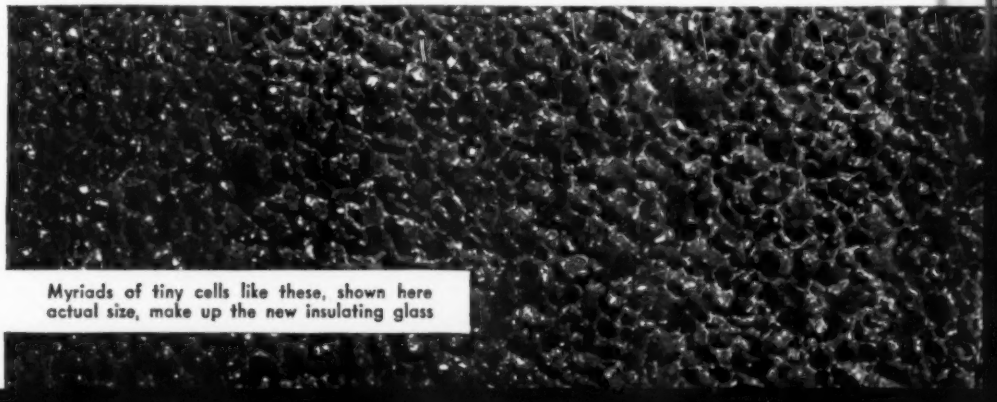
Bubble Glass—

a new insulating material that is fireproof, can be sawed, and floats like cork

By KENNETH M. SWEZEY

BLOCKS of opaque glass that float like cork, insulate from heat, and can be sawed, drilled, and shaped with ordinary carpenters' tools, are the latest and one of the really unique developments in the art of glassmaking. Moistureproof, fireproof, verminproof, rigid, and light, this new product is already being used to insulate refrigerating rooms in such places as meat-packing plants, dairies, breweries, and ice-cream plants. Its possible use as the buoyant element in the construction of lifeboats, life rafts, life preservers, and pontoon bridge supports—substituting for such critical materials as cork, balsa wood, cellular rubber, and kapok, the supply of which has been largely dependent upon imports—is now being investigated actively by experts in the Government service.

Developed in the laboratories of the Pitts-



Myriads of tiny cells like these, shown here actual size, make up the new insulating glass

FOAMGLAS DOES NOT ABSORB WATER EVEN WITH LONG SUBMERSION

To show it won't absorb liquid, cellular glass is weighed . . . . . then immersed for two days in a jar of water, taken out . . . . . weighed again. Surface moisture causes a slight gain

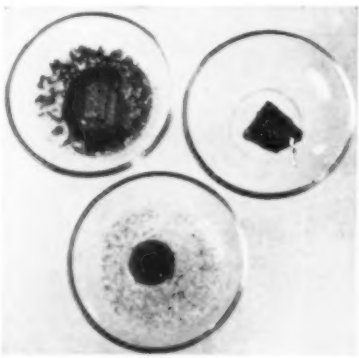
burgh Corning Corporation after four years of research, this new basic product, called Foamglas, is literally a hardened foam of real glass. The molten foam is carefully annealed, to prevent later cracking, and cut into slabs 12 inches wide by 18 inches long, and in four thicknesses ranging from two to six inches. By proper selection of the batch of glass, and by precise control over the times and temperatures used, it is possible to obtain blocks of Foamglas in which the air cells are uniform in size and entirely sealed from each other.

To this mass of sealed-in air cells—more than 5,000,000 to the cubic foot—Foamglas owes its insulating and buoyant properties. Although it requires 50 percent greater thickness than cork to produce the same insulating value, the new product has compensating advantages. Because of its crushing strength of 150 pounds to the square inch, it will support its own weight in any type of construction without crushing or packing. Walls may be built of it merely by cementing together Foamglas slabs with hot asphalt. Ceilings of Foamglas may be supported by a simple framework of angle irons. Absolutely waterproof and vaporproof, the insulating value of Foamglas is not decreased by the condensation of moisture on its surfaces.

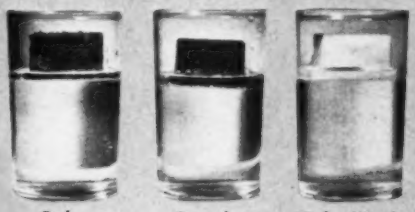
Like other forms of glass, Foamglas won't burn. Being of inorganic composition, it can't rot or provide food for vermin. Its resistance to strong vapors makes it a particularly valuable insulating material for chemical plants. Strong enough to be walked upon and to support reasonable loads, it might make an excellent flooring for refrigerated rooms on naval and merchant ships.

Weighing from 10 to 11 pounds to the cubic foot, Foamglas is but slightly heavier than balsa wood and cork, and only one sixth as heavy as an equal volume of water. It therefore floats almost as high as either of these two common buoyant materials, and may be used to replace either of them in life-saving equipment wherever the danger of shattering by hard, sudden blows is not too great. The construction of the new glass is cellular, but each tiny cell is airtight and because of this, unlike balsa or cork, Foamglas may be submerged indefinitely without deteriorating or losing buoyancy from absorption of water. Prolonged submersions made during tests for buoyancy showed no greater than two-percent increase in weight, and

Balsa (left) and cork (bottom) decompose in acid. Foamglas (right) is unaffected

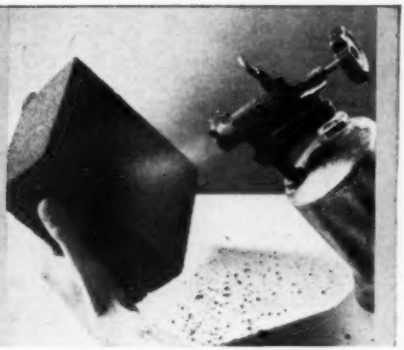


—ITS BUOYANCY COMPARES WELL WITH THAT OF CORK, BALSA WOOD



Cork *Foamglas* *Balsa Wood*

As shown by the test samples above, Foamglas is just a little less buoyant than cork and commercial balsa wood. Cork and balsa, however, lose buoyancy with long soaking. Blowtorch test proves Foamglas to be fire-retardant



this was the result merely of surface pick-up —ample proof that the new material is completely impervious to water.

Although Foamglas is particularly suited to low-temperature insulating purposes, possessing in many cases advantages over any previously existing material, it can be used satisfactorily also as an insulating material for the backing of ovens and furnaces—up to a maximum temperature of 1,000 degrees Fahrenheit.

Foamglas is expected to prove a boon to the food manufacturing and storage industries, not only during the war when it replaces insulating materials not now available, but in the postwar period when the problem of feeding a war-torn world will make new demands on refrigeration.

Foamglas may be drilled for screws or bolts with an ordinary hand drill or sawed to size with a wood saw. It is laid against a wall for insulation simply by cementing the slabs together with hot asphalt

This 78-year-old salt raked in 2,500 pounds of sea moss in two days—$50 at current prices. Rakes have seven-inch steel teeth, handles six to nine feet long, and nets to hold the moss

WAR BRINGS BACK

The Moss Harvest

IRISH moss, which contains a gelatin-like substance used as a base and stabilizer in the manufacture of chocolate ice cream, cheese, hand lotions, and almost 200 other commodities, is being gathered in enormous quantities from a 15-foot belt which extends all along the coast of New England. Long in the doldrums because of cheap foreign sources, the industry has been revived by the war, and native mossers are enjoying their most lucrative business. The towns of Scituate, Mass., and Bailey Island, Me., promise to return to their former status as the chief

Harvested moss is loaded in crates in the dories, hauled ashore, and weighed at the docks. Tally sheets are kept, the men paid two cents a pound

Sea-Moss Rake

Mossers harvest while the tide is out and the beds exposed. Their dories are towed out by launch, and the men work from them, standing far over to one side and making quick, short sweeps with their rakes

This bit of bleached sea moss contains an algal gelatin needed in manufacturing and preserving 200-odd everyday products, from chocolate ice cream and cheese to lotion

centers for mossing in the United States.

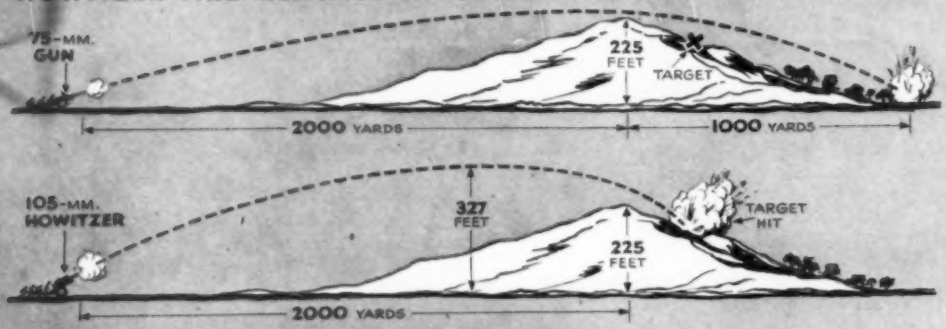
The scientific name for Irish moss is *Chondrus crispus,* and according to botanists it is a perennial plant belonging to the Florideae or red-seaweed family. It attains its maximum development in spring and summer, and is sold commercially in yellow-brown fronds. It can be gathered only at ebb tide when the water recedes below the line of kelp. It grows in feathery clumps, and can easily be raked off.

An hour before the tide goes out, the moss-gatherers tie their dories behind a launch and set out for the best patches. They have but four or five hours in which to work before the beds are covered again. Armed with long-handled rakes, the mossers lean over the gunwales of their small boats and gather in the harvest.

The moss is prepared by black-drying or bleaching. The former is done simply on wooden drying frames or in a drying chamber, where the moss, laid out thinly, is frequently turned. Bleaching takes 10 to 14 days and requires sprinkling with salt water each time the moss dries out until it is almost white. The bleached product is in greater demand.

Next the moss is laid out on racks to dry in the sun—black-dried quickly with its dark color or bleached almost white through a process of sprinkling with salt water each time it dries. This latter may take as long as two weeks. Finally it is baled, as at the right below, and shipped out to market

HOWITZER FIRE REACHES TARGET ON REVERSE SLOPE OF HILL



DOUBLE-DUTY GUN. Taking over the job of the 75 in close support of infantry, our 105-mm. howitzer not only has greater mobility and twice the power of the 75 (see comparison of projectiles at right), but as a howitzer, it can drop shells on an enemy position on the reverse slope of a hill. Drawing at left shows why the 75-millimeter gun was helpless in such a situation

75 MM. 105 MM.

Two Guns For One

105-MM. HOWITZER BEATS THE 75 AT ITS OWN GAME —AND ADDS A FEW TRICKS

By HICKMAN POWELL

IT IS an old, sound military rule that any infantry attack must be supported by field artillery. In the American Army today, under the new triangular-division set-up, the artillery operates more intimately with the foot soldier than ever before.

Divisional artillery functions, not as a separate command, but in smaller units, each of which is part of a combat team with the infantry. Under his command the infantry colonel has his own regiment and a battalion of light field artillery. In the combat team the battalion commander serves as the colonel's artillery adviser. When the colonel wants guns, he doesn't have to go asking for them. He has them—firing batteries of four guns each.

And his guns are a new weapon, the 105-millimeter howitzer, a piece of American design which is twice as powerful, far more mobile, and infinitely more versatile than the French 75 gun which was the doughboy's main artillery support in World War I. The 75 is still a mighty good gun. We still have it in large numbers. But the old tube is doing duty today as an antitank weapon, direct-fire work for which its high velocity and low trajectory admirably suit it. Meanwhile, matching a German field-piece of the same type, the 105 takes over.

The change to the 105 howitzer overcomes one great weakness in the offensive power of the 75 gun. Just as a soldier in a trench is safe from machine-gun fire, so a regiment placed behind the brow of a hill is safe from a field gun of similar flat trajectory. A 75 elevated to clear a ridge 225 feet above it, 2,000 yards away, would carry on another 1,000 yards beyond the ridge, and troops behind the ridge would be safe. A howitzer, however, shoots in a

1 GOING INTO ACTION, the 105 rolls up to the firing position behind a 2½-ton, six-wheel-drive truck. Its high-speed axles give it extreme mobility even over very rough terrain. Eight cannoneers ride the truck, along with ammunition for several rounds of fire. The chief of section, commanding the squad, rides with the driver. Like most modern fieldpieces, the 105 has no limber, its trails being attached to the prime mover

2 When the truck stops, the men hit the ground and uncouple the gun. One of them swings his weight on the muzzle to help disengage the trails

3 Here the trails are free of the pintle. Counterbalanced by the weight of the man on the muzzle, they are lowered to ground. Truck is unloaded

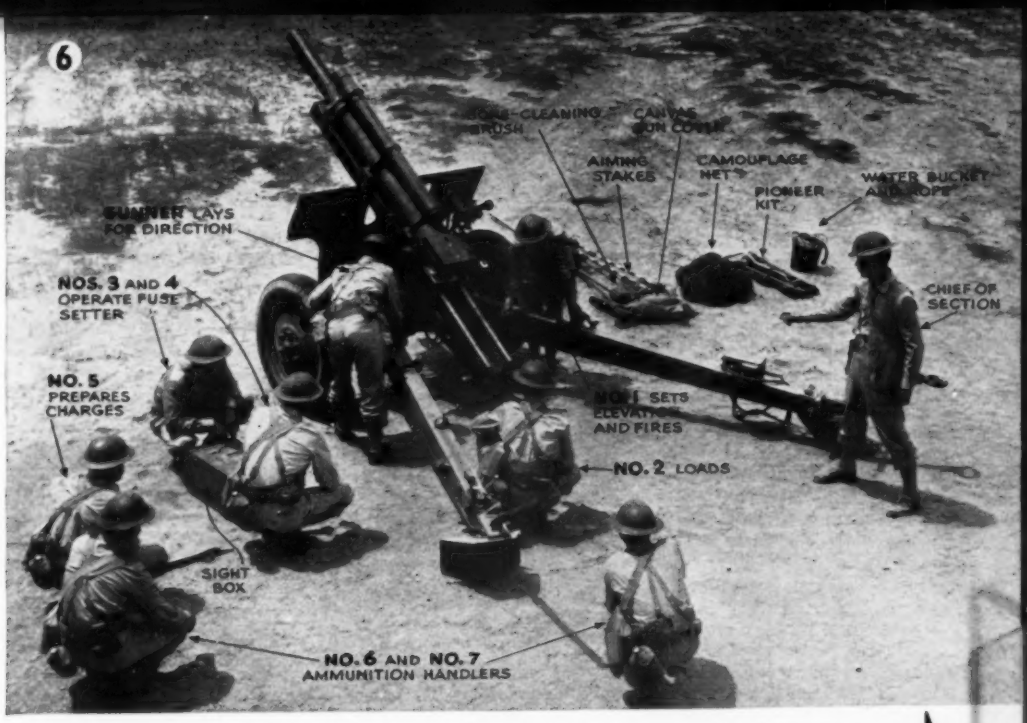
high curve, and the angle of its shells in falling is very steep. It could clean out the front and back of such a hill with equal ease.

To anyone who has played golf, the principle of this is very easily apparent. When you want to shoot over a bunker, or any obstacle, and land on the green dead to the pin, you don't try a low fast shot with a midiron. You want a mashie or mashie-niblick which will send your shot high and drop it straight and true.

The howitzer's high-angle line of fire is of advantage also in screening the position of the fieldpiece. Naturally the cannoneers like to shoot from behind a ridge or a protecting screen of foliage; but if a high-explosive shell armed with a superquick fuse is going to hit a treetop or other obstacle in getting away, it will be more dang-

4 A cannoneer loosens the lock that holds the gun rigid on the axle in traveling. Split trails are spread and spades set for three-point suspension

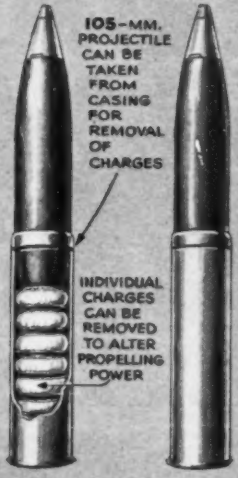
5 Out of its case comes the gunner's quadrant. This carefully guarded instrument is used in laying the gun for elevation according to range



6 Cannoneers at their posts ready for action. The chief of section stands at the right; gunner is at the left of the breech. This is the howitzer squad; for sustained action it would be supplemented by additional cannoneers for relief, and served by an ammunition section with trucks

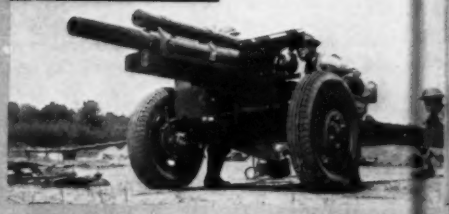
The 105 Is a Dual-Purpose Gun: Doubles as Rifle or Howitzer

Versatile is the word for this jack-of-all-trades among our field-artillery pieces. Used for direct fire like a regular field gun, it can shoot a mile and a half with its shell rising only 150 feet above the earth; as a howitzer, it will lob its projectile from five to seven miles with the shell rising two to three miles into the air and falling almost vertically on its target. Elevation varies from 10 degrees below level to 65 above level. Traverse is about 45 degrees


105-MM. PROJECTILE CAN BE TAKEN FROM CASING FOR REMOVAL OF CHARGES
INDIVIDUAL CHARGES CAN BE REMOVED TO ALTER PROPELLING POWER

PROPELLING CHARGE IS VARIABLE. One feature that contributes to the gun's all-around usefulness is the fact that the charge in its brass cartridge case can be varied to give greater or less carrying power. For varying a charge, the projectile is removed and some of the increments are taken out. This gives several different combinations of power, which, combined with different elevations of the muzzle, determine the range

AS A RIFLE



AS A HOWITZER

. . . to a site that is typical of its use in the field. An ordinary rifle could not work so close to its protective screen because of the danger of projectiles being exploded by near obstacles

Because of its high angle of fire, the 105 can work from the shelter of a ridge or a screen of foliage. At left, it crashes through brush

erous to friend than to foe. One of the first things with a rifle is to sight through the bore and see what your minimum angle of elevation is. With the howitzer this is not so much of a worry. You can work up close to your protective screen.

But the 105 is not a single-purpose gun. It can shoot direct fire, gun fashion, very much like a 75. Its elevation varies from 65 degrees up from level to 10 degrees below level; and it has several different combinations for its brass-encased charges. Add to these variations a traverse of 800 mils, or about 45 degrees total swing to right and left, and you have a weapon of tremendous flexibility for a variety of firing.

It can shoot a mile and a half with its shell rising only 150 feet, or it can shoot five miles with the shell going more than three miles in the air, coming down in almost a vertical fall, for the highest point of flight is two thirds of the way to the target. It can shoot seven miles (its shell rising more than two miles), half again as far as a 75 will shoot.

Its shell weighs 33 pounds, in comparison with the 75's 12½, and this increased bulk gives it a burst effect over an area one third greater in diameter. A 105 shell burst is effective within a radius of about 15 yards, and thus one battery can cover about 100 yards of front.

In mobility and ease of handling the 105 represents a great advance. It is towed behind a 2½-ton truck, with six-wheel drive, which can take it over very rough ground. Its eight cannoneers ride in this truck, together with part of their ammunition.

As in all indirect firing, the gunner of this howitzer does not see his target. Behind it, and directly in line with the piece, are driven two conspicuously marked aiming stakes, one at 50 and the other at 100 yards. It is on these that the gunner trains his cross hairs in the telescopic sight. When the gun fires the first few times, it settles in the ground, and the gunner brings it back on the stakes. On the basis of observers' reports, the artillery commander corrects his fire, and all changes are made with these stakes as the point of reference.

For direct fire, the infantry regiment has an antitank company equipped with 37-mm. guns, but if necessary the 105 can be used for this purpose also, as close as 200 yards. Closer than that its own shell fragments will begin flying back on its own gunners.

Altogether, it's a mighty versatile, useful piece for advancing troops to have along with them. Much better in your own hands than in the enemy's.

RAINCOATS WITHOUT RUBBER

Army Uses Waterproofing of Safety-Glass Plastic

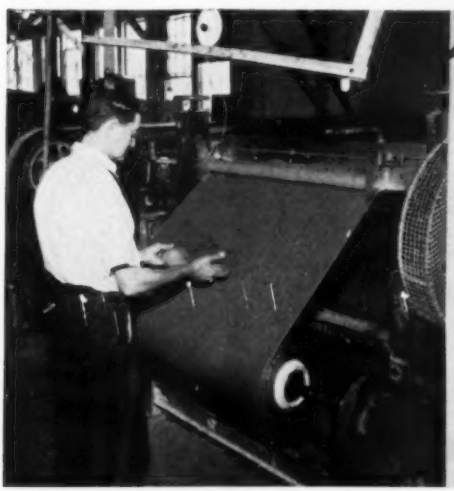
This new Army raincoat, two pounds lighter than the old-style one of rubber, is waterproofed with a tough, resilient plastic originally used in safety glass. In some tests the new material outstrips rubber coating

CONSERVATION of rubber for more essential war needs has its place in the Army as well as in civilian life. Among the latest substitutes is the use of Saflex, the interlayer in safety glass, for waterproofing the Army's raincoats and other fabrics.

This tough, resilient plastic of the Monsanto Chemical Company has been made available for its new duty through a process developed by the Hodgman Rubber Company, Framingham, Mass. The synthetic resin, treated with solvents for spreading or taken off in sheets for calendering, may be processed and cured so nearly like rubber that no new equipment, mechanical adjustment, or labor training is necessary.

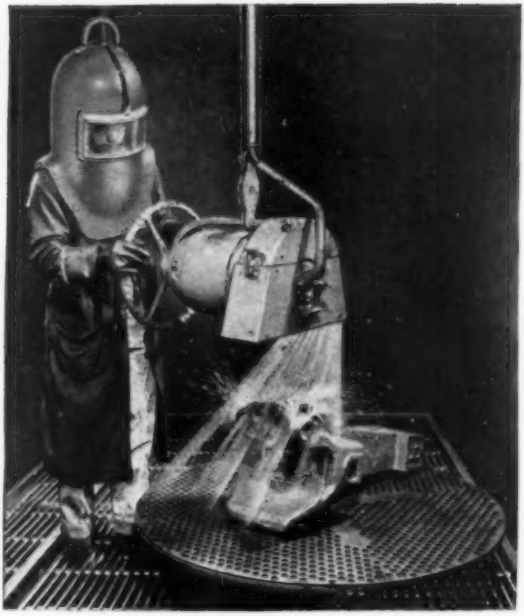
Finished coats are two pounds lighter than the old ones.

Below, plastic-and-solvent cement is spread on fabric, which moves on rollers over a steam table where the solvent is evaporated. Calendering—another method of rubberizing—is also possible

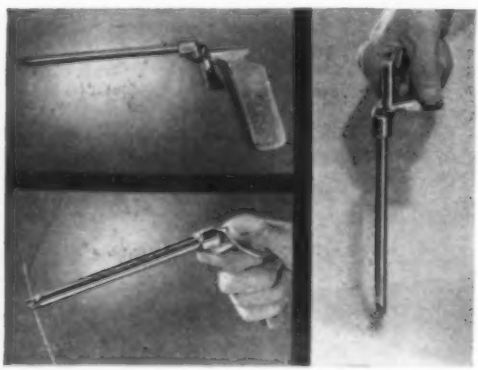


Finished coats, hung inside out on racks, are put in an oven for two hours where a reaction similar to vulcanizing takes place. After curing, the coating won't stick when hot or crack when cold

new Tools

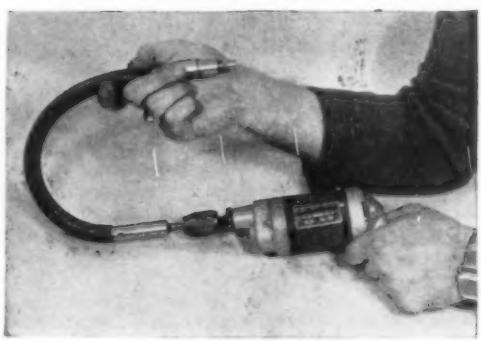


PORTABLE AIRLESS BLASTER. Requiring only an electrical connection for its built-in motor, this blaster can conveniently be raised or lowered or twisted around to clean the nooks and crannies of lathe beds, gears, pulleys, flywheels, valves, car wheels, frames, and housings. It is not portable in the sense that it can be carried everywhere in a shop. Like all blasters, this new device must have a pipe to carry granular abrasive to the cleaning head, and a means of carrying off both abrasive and cleanings. Unlike a pneumatic blaster, it throws metallic shot or grit by means of a centrifugal paddle wheel.



LONG-NOSED CUTTER-RETRIEVER. Shaped like a pistol, with cutting edges at the end of a long, slim barrel, this tool enables the operator to cut wire with a one-handed, one-fingered operation, and to pick up or hold in a powerful grip nuts, bolts, washers, etc. To cut wire, the operator places the wire between the cutting edges and brings down the trigger. This actuates a rod inside the barrel. Practically no thumb pressure is required, as the leverage ratio is 15 to 1. To retrieve a bolt or other object which may be dropped into an inaccessible place, the barrel is poked into the place and the object picked up with the cutters.

FLEXIBLE DRILL SHAFT. Attached to any electric drill with a quarter-inch chuck, this device makes an extension which will bend around corners and enable drilling to be carried on in close quarters. Fitting the end of the shaft into the chuck hooks up the unit and makes it ready for operation. It will take up to a No. 30 size drill. An economy feature is that the shaft drill permits the use of cut-off or broken drills. The device comes in a standard 30-inch length. Core and case are designed for strength and flexibility in long, heavy-duty service.



Six slugs cast from the original shot load turn a shotgun shell into ammunition for home defense

Capt. J. O. Dirks of the Los Angeles Police Department tries out the new load. He found that it will shoot a smaller pattern than standard buckshot

Molded Slugs Make Shotgun Deadly Weapon

BY RECASTING the small shot contained in a shotgun shell into six flat-topped cylinders, Everett Sweeley, district attorney for Twin Falls County, Idaho, has turned the shotgun into a lethal weapon deadly at ranges up to 100 yards.

With a kit which Sweeley has produced, anyone can reload his shells in a few minutes. The shells are opened, the shot poured into a large spoon and melted, the hot lead poured into a six-compartment mold, and the resulting cylinders wrapped in paper in groups of three.

In tests made by Capt. J. O. Dirks, director of training for the Los Angeles, Calif., police department, all six slugs of a 12-gauge shell hit a target at 50 yards, five of them penetrating a two-inch fir plank and embedding themselves in a second.

At the left, shot are being removed from a regular shell for molding into slugs. Melted in a spoon, they are poured into a six-compartment mold as below. Kit includes tools for reloading the shell

BLACK LIGHT AIDS

INSTRUMENT PANELS on military planes can be made to glow under black light. Dials, pointers, and controls coated with fluorescent paint would give off a soft radiance under the rays from an ultraviolet lamp above the pilot's shoulder. Ordinary illumination produces temporary night blindness in the pilot every time he glances at his instrument panel, making it difficult for him to spot an enemy plane for several seconds. The same system can be used on naval patrol boats to help the officers keep a keen watch for enemy submarines

NAVIGATING CHARTS for both planes and ships can be printed in fluorescent inks so that they can be read by the dim light from a fluorescent lamp fitted with a screen of dark purple glass. This would reduce dangerous illumination and, as in the case of the instrument panel above, preserve the user's night vision when he turns his eyes to the blackness outside

BLACK LIGHT, once considered mainly as a medium for trick stage effects, now is a recognized war weapon.

Black light is an invisible beam of near-ultraviolet rays which cause specially treated objects to glow. Ordinary electric fixtures such as hand flashlights or fluorescent lamps can be used as the light source if they are covered with dark purple glass to screen out the visible light.

Black light serves three purposes: to keep light from reaching enemy planes and submarines; to give adequate illumination to friendly troops and civilians; and to keep that light dim enough not to interfere with the sharp night vision needed to spot periscopes and enemy planes.

Research this summer has produced new types of bulbs particularly plentiful in black-light radiation. Black-light lamps now range from a tiny three-watt 12 to 16-volt lamp developed by Eugene W. Beggs and Daniel S. Gustin, of Westinghouse, to a giant searchlight with a white candle power of 350,000,000, capable of throwing an invisible beam several miles.

NIGHT FIGHTERS

FOR BLACKOUTS, street markings would glow under black light from projectors, guiding traffic. Bands of fluorescent paint upon cars would prevent collisions. Luminous caps and scepters have been designed for pedestrians. On country roads, headlamps fitted with black-light screens can pick out fluorescent paint on obstructions

BLAZED TRAILS blaze weirdly when fluorescent paint is daubed on trees and rocks to mark the way. A soldier with an ordinary flashlight screened for ultraviolet light could follow such a trail, which otherwise is invisible

IN WAR PLANTS and other buildings, black-light projectors set flush in the ceiling light up stair treads, carpets, and guide lines to the air-raid shelters when sirens scream. Control panels, fire extinguishers, and first-aid cabinets are also marked

AIRPORT CRASH TRUCK
SNUFFS OUT BURNING PLANES

READY FOR FIRE High nozzle swung out on its boom and front nozzle pointed forward, the truck rushes to a burning plane

Here the two big nozzles, capable of discharging tons of CO_2, are at rest while the truck is idle

THE latest development in life-saving equipment for use at landing fields is a crash truck with maneuverable nozzles that can envelop a burning plane with carbon dioxide, driving back the flames and cooling the hot metal sufficiently to allow a rescue crew to pull out the occupants.

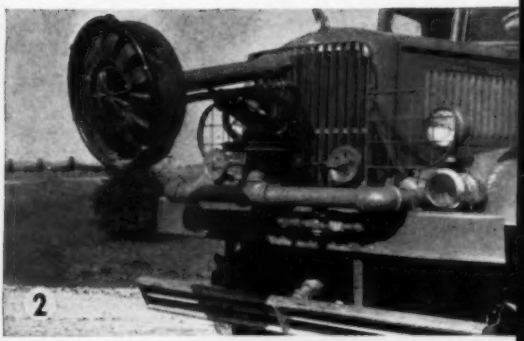
One nozzle is mounted on a long boom which may be raised or lowered and swung to the right or left, while the nozzle itself may be tilted through approximately 90 degrees. Another is mounted on the front of the truck, and is similarly maneuverable. This nozzle can discharge more than a ton of liquid carbon dioxide within one minute

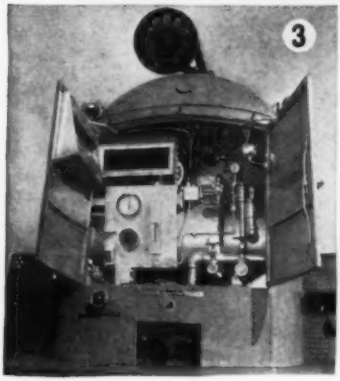
SPECTACULAR TEST

1 Saturated with gasoline, this old plane was allowed to . . .

2 . . . burn for 90 seconds before the fire truck was summoned

3 The carbon-dioxide gas from the nozzles smothers the flames



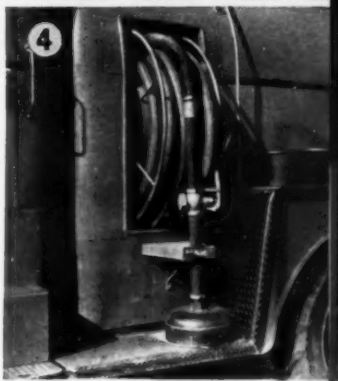


1 Pistol-grip controls on the truck's instrument-panel make it easy for the driver to operate the nozzles

2 The front carbon-dioxide nozzle in its forward position. Note the spray nozzle below it to protect wheels

3 A compartment at the rear of the truck houses the refrigerating unit to cool the main carbon-dioxide tank

4 Hose and hand nozzle, seen in use in photo at right, below, is stowed on a reel at the side of the truck



along with a small amount of water. The quenching and cooling action of water is valuable on a heated plane, even though water cannot be used on an oil fire as a primary extinguishing agent.

A third nozzle extends like a bumper across the front of the machine. It throws an extinguishing and intensified cooling screen in front of the wheels, enabling the truck to be driven very close to a fire. Additional equipment consists of a hose reel and play pipe on either side.

The carbon dioxide is transported in a single tank which holds three tons and is part of the truck. This tank is heavily insulated and refrigerated to maintain a constant temperature of about zero Fahrenheit and a reduced pressure of only 300 pounds per square inch.

The truck was designed by engineers of the Cardox Company of Chicago, and is being tested at Wright Field, Dayton, Ohio, by the Army Air Forces, under the supervision of Lieut. Col. Rudolph Fink, of the Wright Field Equipment Laboratory. The prime purpose is to save lives, but if a plane can be saved too, so much the better. Although the preliminary tests were successful, the new truck has not yet been accepted by the Army.

War's End will

By JOHN H. WALKER

AFTER this war is won, the American people should be able to travel faster and live better than ever before. The money and energy being poured into our war effort now will pay us dividends years after the victory itself.

Three main factors in the war effort guarantee a better life for Americans:

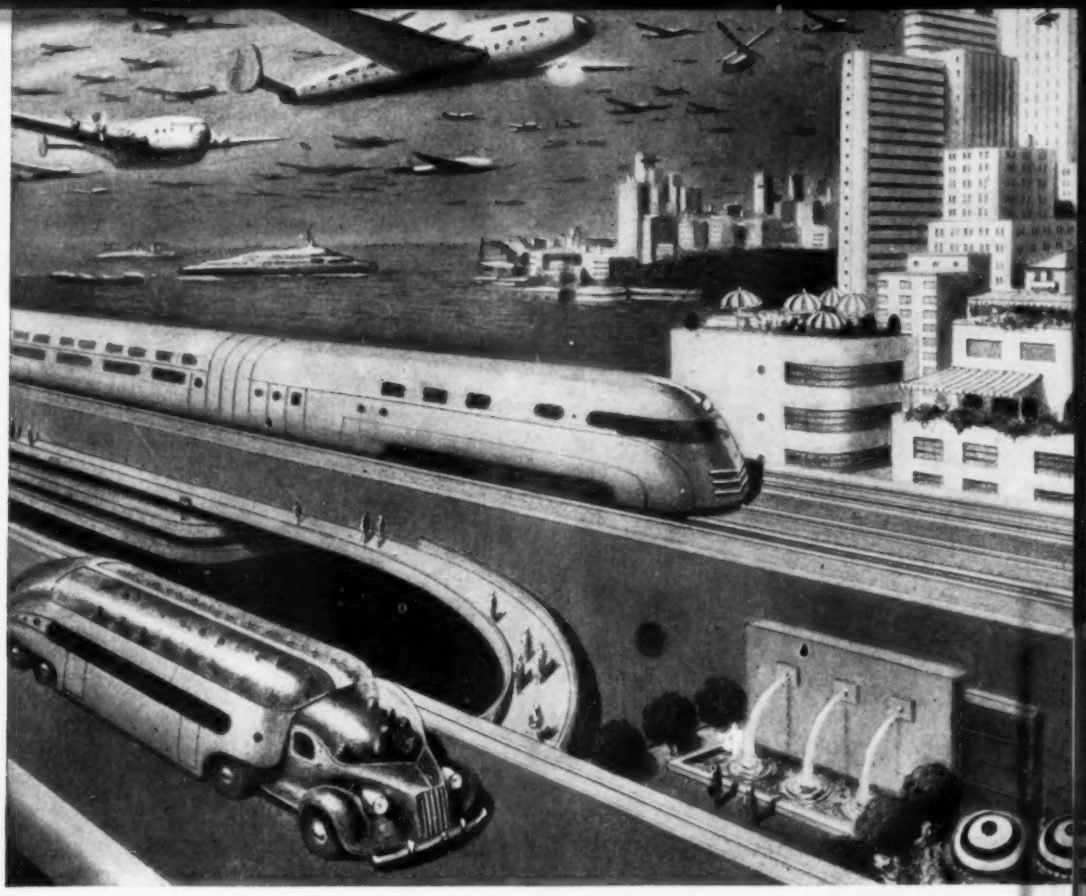
New Plant.
New Discoveries.
New Skills.

War secrecy bars any complete compilation of the tremendous plant expansion carried on in the past two years. Some of the new factories and arsenals have been well publicized, while others have been discreetly played down to avoid attracting the attention of saboteurs or revealing too much about our war-material manufacturing schedules. But that expansion has been on a huge scale. One good example which can be cited is that of the shipbuilding industry, which has expanded to something like 600 percent of its former capacity.

We have entire new factories in the Middle West, built to produce tanks, bombing planes, and engines. And very much in the public eye are the new oil pipe lines being built to supplement our existing system linking oil fields to industrial areas.

All this new plant is destined to become a permanent part of our industrial heritage. The problem of reconversion to civilian use may be a knotty one in some specialized cases, yet the fact remains that we will have this new equipment to use.

New discoveries most certainly will flow into the current of our economic life under



bring a better life

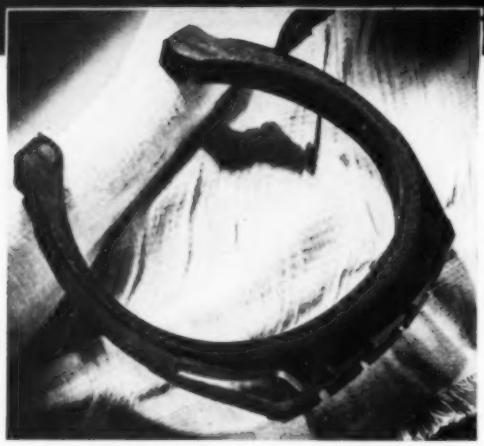
the pressure of greatly increased wartime research by almost every branch of industry. Chemistry, metals, plastics and glass, electricity and radio, construction, communication and transportation, fabrics and food and medical science—all these and virtually every other field of human activity will experience the forward thrust of research and development carried out under forced draft.

Along with this forced advance of technology will go a wartime pooling of brains and patents in industry, and it is not too much to say that before the war is over millions of Americans, young and old, will have learned some kind of new skills, making them better fitted to work and produce for the greater wealth of the whole nation.

New skills not only make new industries possible; they make them inevitable. Take one example: Hundreds of thousands of young Americans will have learned how to fly or navigate or overhaul airplanes in this war. Afterward they will want light planes to fly, even if they return to totally different civilian work. That demand will create a private-airplane industry far beyond anything we have known. Many aeronautical scientists believe that the plane these people will really want is a workable helicopter type, able to land and take off almost vertically, at dead slow speed. And that, in turn, is a problem for research; there will be no lack of plant to build the ships.

We can't look far enough into the mist of the future to assemble any detailed list of things to come. Yet the broad general outlines of a better life are clearly distinguishable. Our interpretation of these outlines has been based almost entirely on material

TOMORROW'S CAR. Automotive engineers looking ahead to postwar designs foresee lighter, cheaper, and safer cars. Plastic tops, frameless chassis, hydraulic drives, superchargers, lighter engines, and streamline bodies are slated for after the war. As for price—estimates range from $500 to $1,000 for small cars, and from $1,200 to $3,000 for larger models. As for economy—the smaller cars will give at least 30 miles to the gallon while even the larger cars will be expected to give 20 miles. Regular-grade gasoline will be 80 octane; premium grade, 100 octane



Rayon-cord fabric is making Army tires stronger. After the war, long-wearing synthetic-rubber tires with rayon cord will be available to civilians

supplied by the major U. S. industrial concerns, research organizations, designers, engineers, and Government technical bureaus.

Right at the start it can be said with certainty that our life in the future will be characterized by greatly speeded-up transportation and the extensive use of new building and fabricating materials, both natural and synthetic.

No field has more dramatic possibilities than that of transportation, and the greatest developments, of course, will come in the air.

The war's end will find America with many thousands of bombing and air-transport planes, some of which will be almost immediately convertible to peacetime use.

In addition, we will have unrivaled facilities for building and designing planes, and it is certain that entirely new types must and will be developed to meet the keen international competition which is sure to spring up. We will have one other great advantage, already in being, in our elaborate Army Air Transport Service, with all the major U. S. air lines co-operating in maintaining service all over the world on a scale of organization scarcely dreamed of three years ago.

The cargo plane of the future will be specially designed for its work, will have a very high lift factor, will have both nose and side hatches for loading cargo, and will have a relatively low landing speed to get into small airfields.

If airmen are inclined to speculate mostly on their future cargo business it is not because they aren't interested in passenger traffic, but rather because they take it pretty much for granted that planes will be the normal medium of high-speed travel over any reasonably long distances. Giant passenger planes are sure to come along; there can't be a designer in the business who hasn't at least sketched out an idea for a super-airliner complete with sun lounge, promenade deck, eight engines, etc., and some of these designs had been well publicized even before the war. Most

BETTER ROADS. We are already building a highway to Alaska, and another motor road is being driven south through Latin America. Others are being planned . . . . . as super-speed highways like the one illustrated below. To provide landing facilities for private flyers, flight strips will parallel the roads where they follow the direction of the prevailing wind. Gas stations, with hangar space, will take care of the fuel needs of small planes as well as automobiles. Elimination of all unnecessary curves and grades will cut touring mileages

designers believe these future planes will operate between land bases; presumably they will grow to an optimum size conditioned by their landing fields, just as ocean liners were conditioned by the channels and canals they had to navigate and the docks they could berth alongside.

The flivver-plane trade with private pilots must depend for its real success on the development of a low-cost, completely safe airplane and the building of literally thousands of new airfields. Designs for the planes are in hand, most of them using tricycle or four-wheel landing gear, and having collapsible wings. Wartime research, by the way, has given the industry invaluable experience with these features.

Relations between the automobile and airplane industries will play an important role in our postwar business life. The two have been brought together by war, and can't possibly avoid being greatly influenced by each other, the plane builders by Detroit's capacity and mass production techniques, the auto men by airplane standards of precision and high quality.

As for your postwar automobile itself, the experts are in some disagreement. Conservative engineers caution that we shouldn't expect too much, and suggest that the first new cars built will be 1942 models, no matter what else they may be called. This may be true for some firms, but not necessarily for all of them.

The auto companies now making planes, guns or parts had to do a thorough job of converting their plants, tearing out most of the existing fixtures, including the jigs

AERIAL FAMILY CAR. Flivver-plane trade with private pilots after the war will depend on the development of a low-cost, completely safe airplane. Here Jo Kotula, artist, has combined his ideas with those of Fred Weick, aircraft designer, to forecast the postwar private plane. For safety and efficiency, it is powered by two pusher motors. It has retractable tricycle landing gear and high-lift flaps for steep take-offs and landings on small fields, while large windows allow maximum vision

and dies with which bodies and fenders are fashioned. Some of this equipment may be stored and kept in good condition, but much of it simply cannot be, and will inevitably become useless even if it isn't scrapped for metal. So it would seem that the war's end should bring the chance of a lifetime for any company that has thought about doing a radical retooling job for a radically improved car.

In any case, even the conservative engineers agree that there will be a genuine postwar car, even if its design and production lag a season or two after the actual end of the war. The Society of Automotive Engineers, reporting on a questionnaire survey, says the postwar car will resemble its prewar cousin but will be lighter, more streamlined, and mechanically more efficient.

It may sacrifice a little in performance, especially such qualities as acceleration, but will pay off a dividend in fuel economy. Prices probably will be somewhat lower. The average opinion was that cars would range from a $500 job, giving at least 30 miles to a gallon of gas, up to a luxurious $3,000 car which still would be expected to give 20 miles to a gallon in ordinary use.

It may be possible to increase the efficiency of cars by trimming off as much as 1,000 pounds weight without appreciably reducing the size or altering the vehicle's sturdiness and riding qualities. This would be accomplished by the use of new materials, many of which constitute an actual mechanical improvement. Aluminum is sure to be extensively used, and some designers are convinced that plastics are the coming material in automobile construction.

As for some of the more advanced designs, one contemplates a closed car with a round top of strong, light plastic material supported by several slender columns rising at angles from a wide, streamlined plastic body. Another type would provide a retractable top made of a solid molded piece of transparent plastic. This could be entirely withdrawn into a well at the rear. Still other designs embodying transparent plastic would incorporate a polaroid device which could be adjusted to shade off excessive sunlight or glare.

Future super-speed highways may lead to the adaptation of one airplane feature—

stub wings with inverse profile built into the sides to help keep the car on the road. At frequent intervals, moreover, those super-highways will be widened at the sides with landing strips for airplanes to use as supplementary airports.

What about the railroads and shipping in this transportation scramble? Their future apparently is more utilitarian than dramatic, and they will not be subject to such rapid change and development in the postwar period, even though they will have great and important work to do. Airplanes can scarcely compete for bulk ocean cargo, and passenger shipping presumably will stress comfort, recreation, and spaciousness rather than speed. It is a little hard to imagine any nation sinking money in new superliners, but the ways of pride and national tradition are inscrutable.

Some Americans who were writing the railroads off as obsolete even before this war must have received a shock to learn of the magnificent war service the nation's rail net was performing, hauling more than 40 billion ton-miles of freight each month—an increase of 70 percent over the peacetime load. Railroading has survived despite taxes and competition because it is the most inherently efficient form of surface transportation, and it isn't through yet.

After the war, the railroads will compete with faster, lightweight passenger flyers, and they will have the factor of all-weather reliability to help them. Some railroads may adopt the air-line idea of serving meals at the passenger's seat. On the technical side, the trend in motive power probably will be to Diesel engines and electricity, although some engineers think the steam-turbine principle might be used.

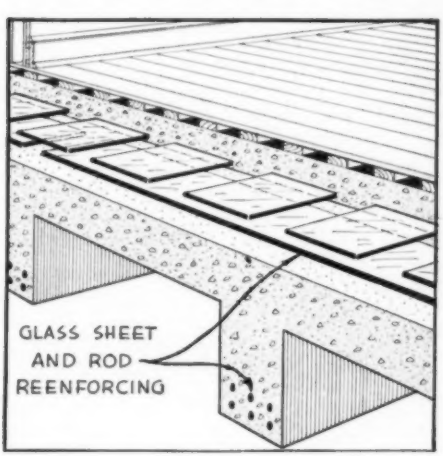
One general word about transportation—in the postwar world Americans will travel faster than ever, and at less cost.

Light materials—glass, plastics, plywood, and the "magic metals" like aluminum and magnesium—will play an important role in the better life after this war.

The future of these materials is so rich in possibilities that some of the predictions made for them seem completely fantastic. There is a possibility, for example, that glass plates might some day replace steel rods as reinforcement for concrete beams and structures. This is a wartime idea, born of the lack of steel. Yet glass has certain advantages for the purpose. It is lighter than steel, thus reducing the weight of the beam required to carry a given load, and its coefficient of expansion is very near to that of concrete, which would tend to reduce internal strains caused by thermal expansion and contraction. Other possible uses for glass include the linings of baggage chutes and the outer casings of household furnaces. A practical kitchen stove made largely of glass already has been built and tested.

Plywood airplanes are already in existence and rated highly successful. The war has given this building material a powerful boost; L. H. Meyer of the United States

NEW USES FOR GLASS. One possibility, shown below, is the use of glass plates instead of steel rods as reinforcement for concrete beams and structures. At the right is a practical kitchen stove made up largely of glass



PIPE LINES. The map above shows the pipe lines built, being built, and planned. By the end of the war most of these will be completed to provide a network of pipe lines to carry oil from the fields to consumers in the east and north

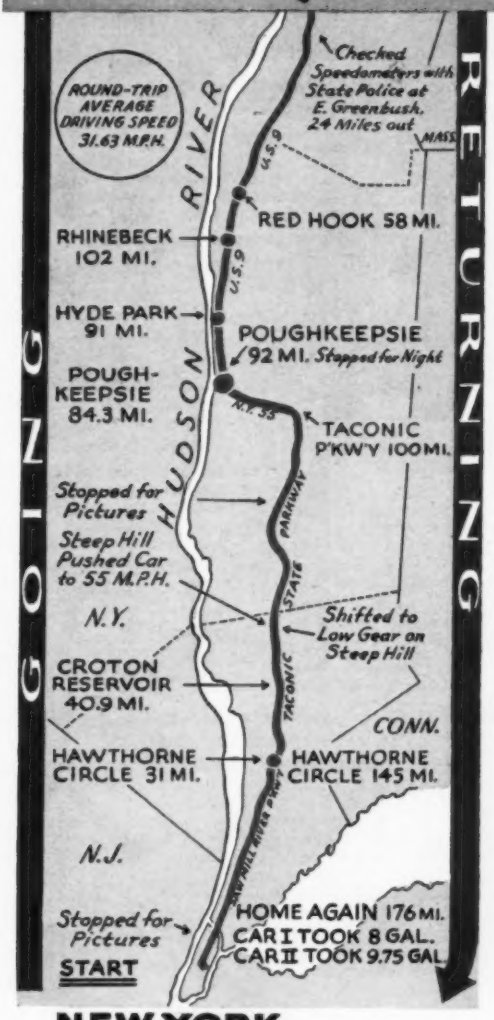
Plywood Corporation estimates that at least 1,000,000 technicians and workmen have gained some knowledge of it. Plywood is a good bet for both prefabricated and field-fabricated housing after the war.

Unquestionably there will be an amazing spread in the use of aluminum and magnesium when these light metals again become available for civilian use. Magnesium production was sharply restricted before the war by patent agreements, but is now being made in several plants.

Perhaps the most conspicuous use of light metals will be in architecture. Aluminum has been used in the past mainly for exterior decoration, and engineers (not punning) think that was just scraping the surface. Your new home after the war may have aluminum window sash; some were installed in office buildings as much as 12 years ago and *(Continued on page 229)*

At left, map of the trip made by two identical-model cars, one with half its cylinders inoperative, to test the converted motor's efficiency. Data is from the author's log

WHAT HAPPENS WHEN YOU Cut Your Motor in Half



HOW AN AGING AUTOMOBILE WITH HALF ITS CYLINDERS DEAD SAVES YOU GASOLINE

By SCHUYLER VAN DUYNE

TO learn what a motorist with an average, or below-average, car gains by using only half of its cylinders, I tried it out. Sticking to the speed limits, I boosted the gasoline mileage of a 1938 Ford V-8 standard four-door sedan nearly 25 per cent on a test round trip between New York City and Schenectady, N. Y.

I probably shifted into second gear more than any 1920 motorist ever did on the same run. Once I even had to drop down to low to get up a hill, and on the ramp of a Poughkeepsie parking garage the car would have stalled in low if I had not slipped the clutch and raced the motor. But—the 359-mile trip, at an average speed of 31.63 miles an hour, saved almost four gallons of gasoline. That was a week's supply with an Easterner's "A" ration book, and enough for 100 extra miles in the car used.

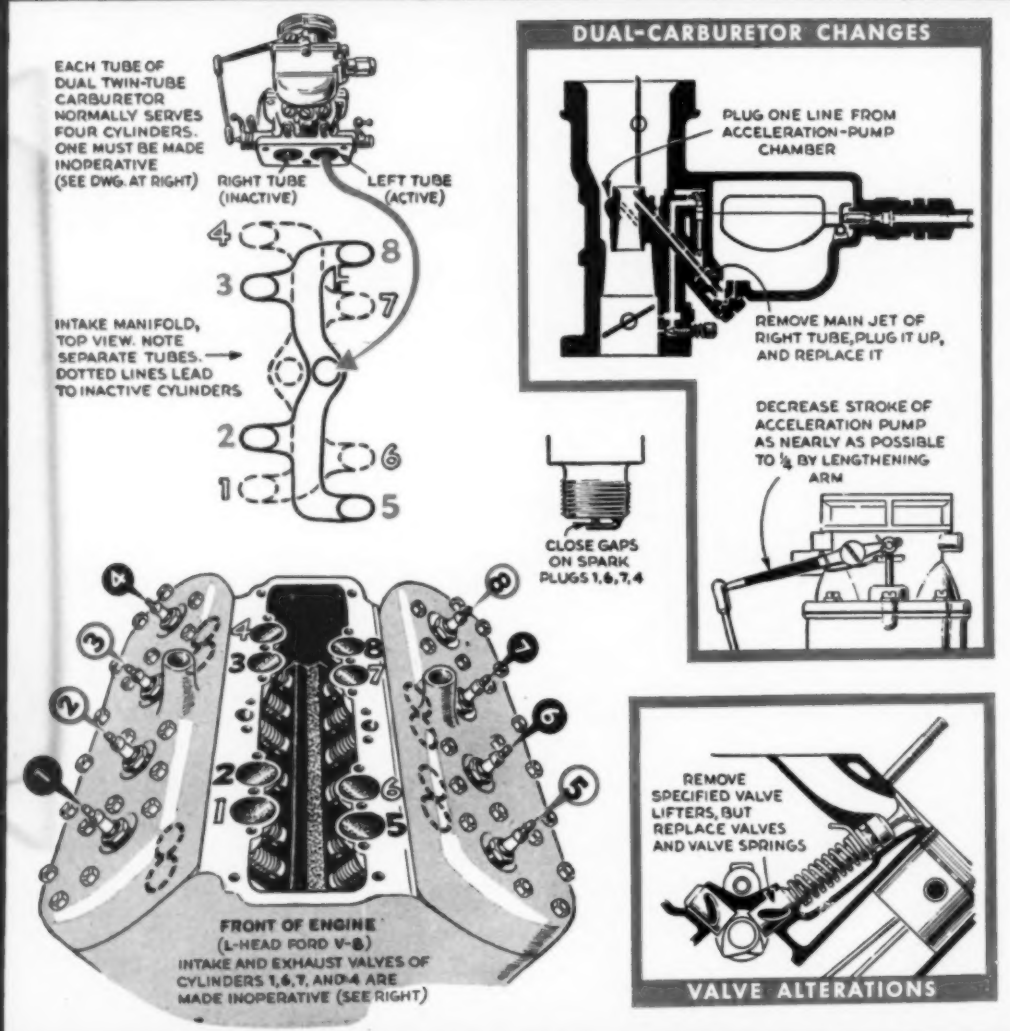
For a fair estimate of the gas saving, a second car of identical make and model, with the same case history, was the standard of comparison. Both cars had gone about 70,000 miles, and neither had nodded to a skilled mechanic in six months. Car 1, which I drove, was "souped down" in the service department of Harold S. Jonas, Inc., Ford dealers in New York City, which lent both the old cars for the test. Car 2 was driven by Robert Smith, staff photographer. The engine of Car 2 was untouched before the trip, except for an oil change which Car 1 also had, and both chassis were newly greased, all tires inflated evenly, and both of the 16-gallon gasoline tanks filled to the necks.

(CONTINUED)

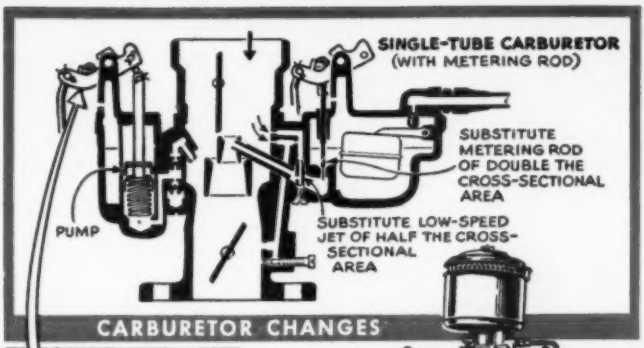
The mechanical changes on Car 1, cutting out half the cylinders, were made according to recent suggestions of the Sun Oil Company of Philadelphia. Lifters were removed from the intake and exhaust valves of the two center cylinders in the left bank of four, and the end pair in the right bank. The valve springs were then relocked so the valves seated firmly, but the valves no longer were opened by the camshaft.

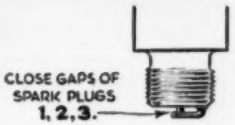
These four cylinders (the other set would have done as well) normally are fed by a manifold tube separate from the tube supplying the other four, and the two manifold tubes attach to separate throats of a dual carburetor. So the main gasoline jet feeding the nozzle in the throat of the dead side of the carburetor was plugged, as was one side of the by-pass between the two manifold tubes into which the windshield wipers, and the vacuum brake of the distributor, exhaust. One branch of the acceleration-pump lines into the two carburetor throats was plugged, and the pump stroke was decreased as closely as possible to one quarter. (This would be half on a single-tube carburetor, and its nozzle would not be plugged.) *(CONTINUED)*

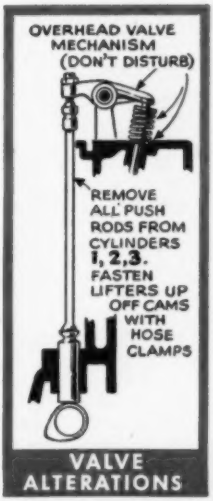
How the L-Head V-8 Ford Is Altered To Run on 4 Cylinders

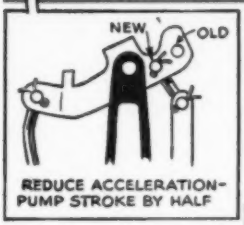

EACH TUBE OF DUAL TWIN-TUBE CARBURETOR NORMALLY SERVES FOUR CYLINDERS. ONE MUST BE MADE INOPERATIVE (SEE DWG. AT RIGHT)
RIGHT TUBE (INACTIVE)
LEFT TUBE (ACTIVE)
INTAKE MANIFOLD, TOP VIEW. NOTE SEPARATE TUBES. DOTTED LINES LEAD TO INACTIVE CYLINDERS
4
3
2
1
8
7
6
5
DUAL-CARBURETOR CHANGES
PLUG ONE LINE FROM ACCELERATION-PUMP CHAMBER
REMOVE MAIN JET OF RIGHT TUBE, PLUG IT UP, AND REPLACE IT
DECREASE STROKE OF ACCELERATION PUMP AS NEARLY AS POSSIBLE TO ¼ BY LENGTHENING ARM
CLOSE GAPS ON SPARK PLUGS 1, 6, 7, 4
FRONT OF ENGINE
(L-HEAD FORD V-8)
INTAKE AND EXHAUST VALVES OF CYLINDERS 1, 6, 7, AND 4 ARE MADE INOPERATIVE (SEE RIGHT)
REMOVE SPECIFIED VALVE LIFTERS, BUT REPLACE VALVES AND VALVE SPRINGS
VALVE ALTERATIONS

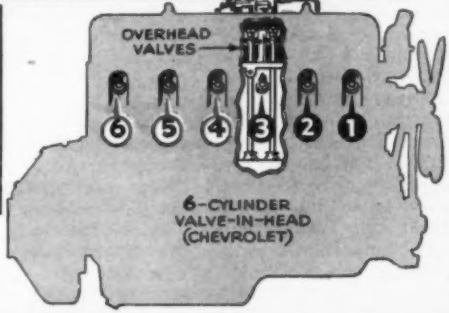
Changes for the Overhead-Valve-Type 6-Cylinder Chevrolet


SINGLE-TUBE CARBURETOR
(WITH METERING ROD)
SUBSTITUTE METERING ROD OF DOUBLE THE CROSS-SECTIONAL AREA
SUBSTITUTE LOW-SPEED JET OF HALF THE CROSS-SECTIONAL AREA
PUMP
CARBURETOR CHANGES

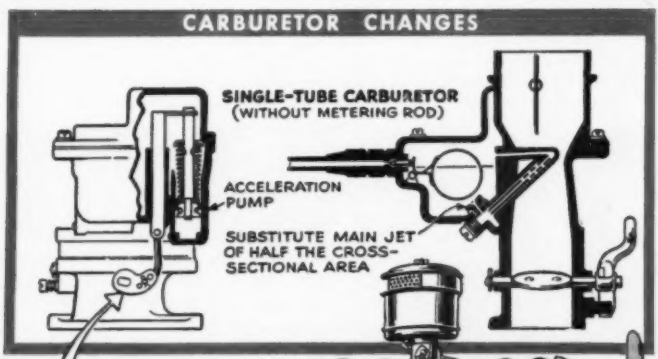


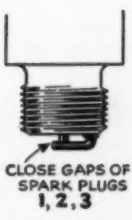

OVERHEAD VALVE MECHANISM (DON'T DISTURB)
REMOVE ALL PUSH RODS FROM CYLINDERS 1, 2, 3. FASTEN LIFTERS UP OFF CAMS WITH HOSE CLAMPS
VALVE ALTERATIONS

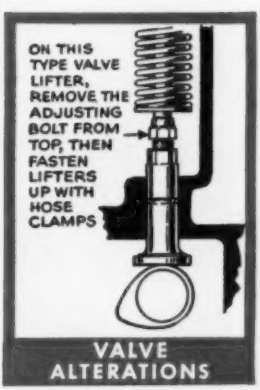


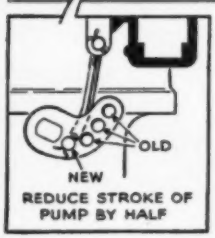


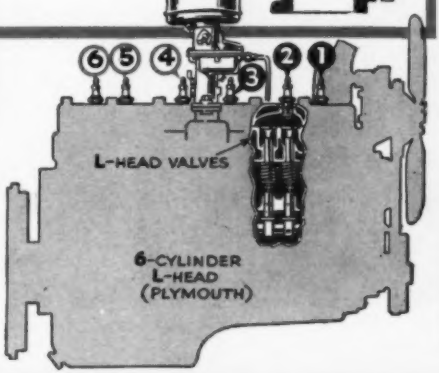
L-Head 6-Cylinder Motors Like Plymouth's Follow This Plan











DRAWINGS BY STEWART ROUSE

The only other changes were to close the gaps in the dead-cylinder spark plugs and to step up the engine idling speed. The motor was now an even-firing four-cylinder one, with four dead cylinders going along for the ride. Their pistons simply compressed air and let it expand again, and their contribution to performance was a negative one—drag.

Setting out under a summery sun from midtown New York, we headed for the West Side Highway, turned uptown to Henry Hudson Parkway, switched to the Saw Mill River Road. Long before reaching the Hawthorne traffic circle, where we were to cut into Taconic State Parkway for Poughkeepsie, I had rediscovered a variety of old driving sensations. Gone was any semblance of jack-rabbit acceleration for a shift from low to second. If the shift to high came before the speed reached 18 miles an hour, pick-up was laborious, usually broken by some initial bucking. Above 18, high-gear acceleration was smooth, but still lazy.

As we entered Taconic Parkway's first level stretches, I temporarily forgot second gear—until the first moderate hill. Car 2 pulled away easily. I held a conference with myself as I plugged along at 25 in second, lagging farther and farther behind. This, I realized, was less than half a motor. But the hill was not steep for Car 2. More than 300 miles of driving over many hills lay ahead. I knew that the engine was functioning properly, such as it was. What could be done to make the drive less tedious?

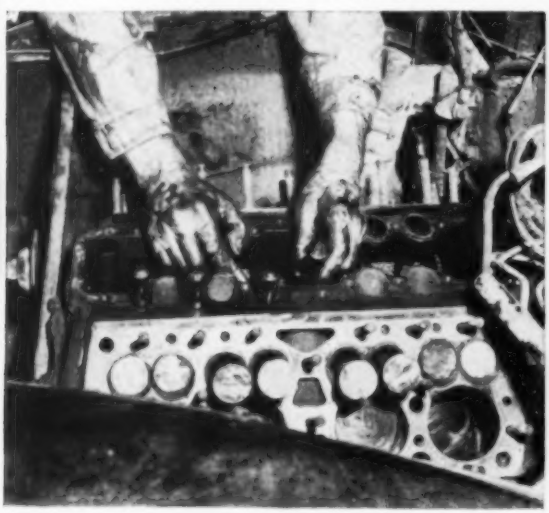
In a few miles I had the answer when it struck me that this was perhaps the least hectic driving I had ever done. No racing away from traffic lights to beat the other fellow. The car wouldn't race. No passing on hills. It couldn't. No dynamiting along straightaways. This race horse was bridled in for keeps. I settled back to my driving, kept an eye on the pace-setter ahead, wrote in my log, and enjoyed the air and scenery as I never had before. Just what had been my rush all these years?

On the whole trip, only two minor events marred the real driving pleasure that I had discovered, both on the same hill near the Dutchess-Putnam County line. There, on the trip out, the car seemed momentarily to be floating on air with unaccustomed motions. I snapped out of it to find that the long steep grade had boosted my speed up to 55, with the throttle closed. At the same hill, on the return trip, I shifted to second as usual before the hand dropped to 20 miles an hour, but instead of holding the speed or increasing it, the shift failed in its purpose completely. With a sheepish, silly feeling, I dropped down to low and chugged over the hilltop a few minutes later. Smith was waiting for me beside his car, yawning.

At Schenectady the first proof of improved gasoline economy was shown. Splitting the slight difference between the indicated mileage on the two speedometers, we had covered 183 miles. Refilling both gasoline tanks, these facts came to light:

Car 1 used 7.7 gallons.
Car 2 used 9.7 gallons.
Car 1 averaged 23.76 miles per gallon.
Car 2 averaged 18.86 miles per gallon.
Mileage improvement: 25.97 percent.

Removing valve lifters from the Ford V-8 engine that powered Test Car 1 on the economy run. Note the raised valves in the foreground. Later these valves and their springs were put back



Important detail in altering Fords: Plug one side of by-pass between the two separate intake-manifold systems

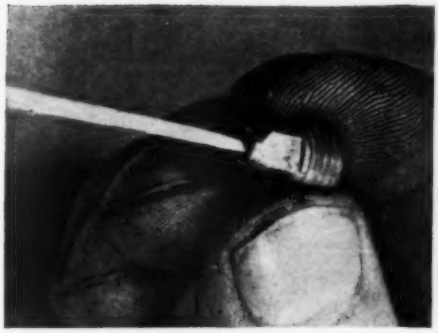
For the return trip, over the same route except for a few miles between Schenectady and Albany, our speedometers clocked 176 miles. And after refilling both tanks arithmetic disclosed:

Car 1 used 8 gallons.
Car 2 used 9.75 gallons.
Car 1 averaged 22 miles per gallon.
Car 2 averaged 18.05 miles per gallon.
Mileage improvement: 21.87 percent.
Further data shows:

Driving Time	*Average Speed*
GOING:	
5 hrs., 48 min.	31.55 m.p.h.
RETURNING:	
5 hrs., 33 min.	31.71 m.p.h.
TOTAL	
11 hrs., 21 min.	31.63 m.p.h.

Samples of the "regular" gasoline we used were taken from the tanks after each filling and, allowing for them in the foregoing figures, they were submitted to the Ethyl Corporation, makers of antiknock additives for gasoline, for analysis of octane ratings. While octane rating does not perceptibly affect mileage unless engines are adjusted to get the fullest benefit from the antiknock quality, the samples showed that on the trip out Car 1 was using fuel with an octane rating of 76.9; Car 2, 76.5. On the return trip: Car 1, 75; Car 2, 75.

The method of altering the engine for the test trip was, in general, the same as that for any car. It usually costs from $10 to $20, and takes a skilled mechanic a half day. The reader may weigh the personal and wartime advantages of sacrificing more than half his engine horsepower in exchange for important gasoline savings at moderate speeds. Once he gets used to the power loss, driving pleasure for the most part re-



On dual carburetors, plug one main jet (above). On single type, use larger metering pin and smaller low-speed jet or, if pinless, use smaller main jet

turns. In thousands of miles of tests on five makes of cars, the Sun Oil Company reported no damage to any of the motors. Harmful vibration—the alleged detriment advanced by some critics—is a myth. Your once statically and dynamically balanced moving engine parts are as balanced as they ever were, and the only noticeable difference is in the doubled spacing of the power impulses. At low speeds, too, as noted, the split engine may buck. You'll soon learn to control this by shifting gears as you get used to it.

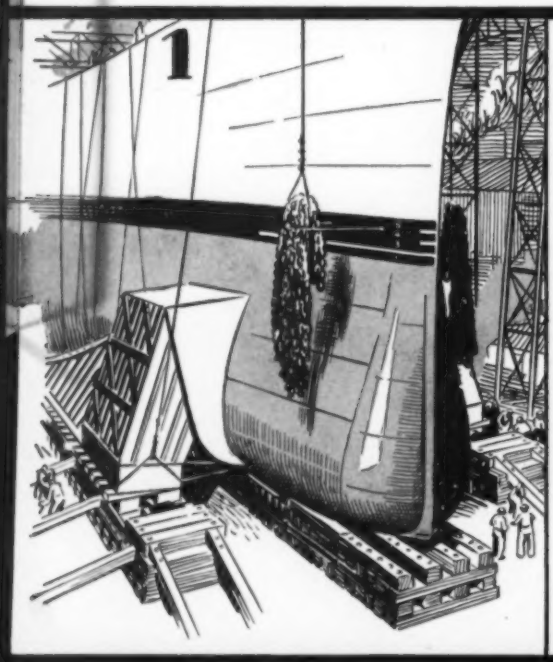
Simplified, the changes consist of cutting out half the cylinders by stopping their valve action, reducing the gas reaching the others by one half, and short-circuiting the unneeded spark plugs. Every other cylinder, in firing order, is killed, giving a choice of either half. For all sixes the firing order is 1-5-3-6-2-4, *(Continued on page 234)*

The cop isn't getting a ticket. A New York State Trooper from the Traffic Bureau, Troy, he has just checked the accuracy of the test cars' speedometers and his findings are being recorded

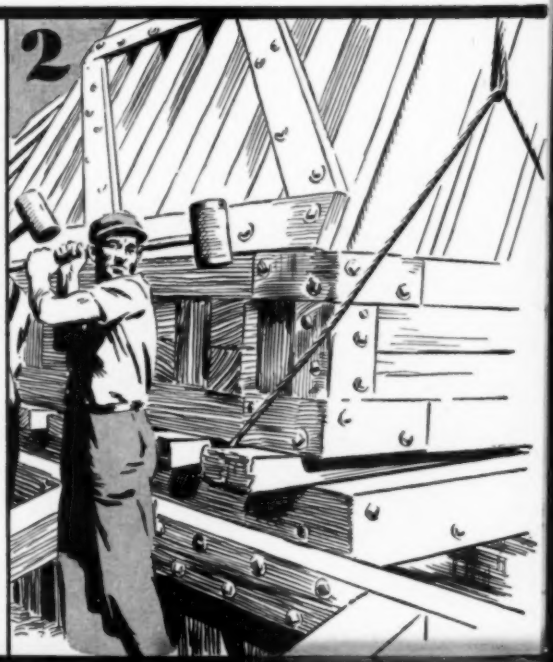
U. S. S. IOWA, world's largest battleship, sliding down the ways at New York Navy Yard, Brooklyn

Heaviest Ship Is Launched

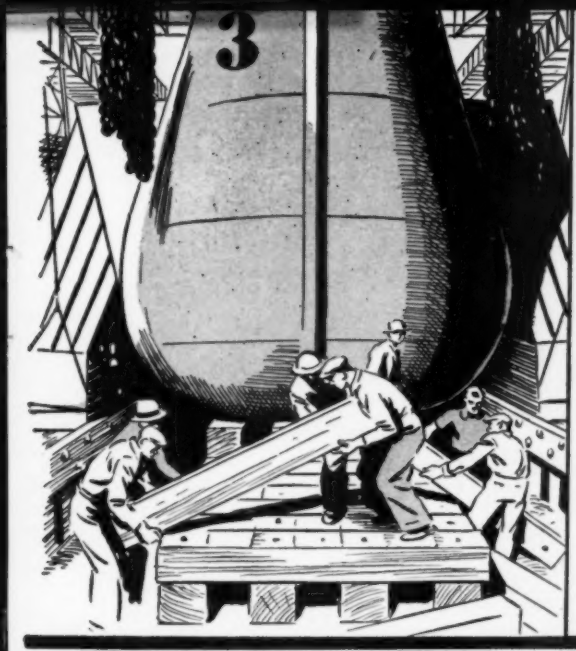
BECAUSE of military secrecy, the details of the recent launching of the world's largest battleship, the 45,000-ton U. S. S. *Iowa*, cannot be divulged. However, in the drawings on these pages our artist shows his conception of the steps necessary in getting a ship of this size down the launching ways and into the water. The new *Iowa*, the fourth U. S. Navy ship to bear the name, carries main batteries of 16-inch guns on her 880-foot hull. She is the first of six vessels in her class. Five others now building are the *New Jersey*, *Missouri*, *Wisconsin*, *Illinois*, and *Kentucky*. The *Washington* and *North Carolina*, recently commissioned and now in service, are in the 35,000-ton class.



With her hull completed, the ship stands over the ways, her weight supported by the keel blocks under the hull and by the cribs and shores on which she was built. The ground ways have been coated with tons of grease. All is ready for the operations that will free her to slide into the water



The first step in the launching consists of driving hundreds of long wedges into V-shaped spaces that separate the sliding ways and the angular supports or poppets which are part of the cradles. The driving in of these wedges lifts the ship and transfers its weight from the keel blocks to sliding ways

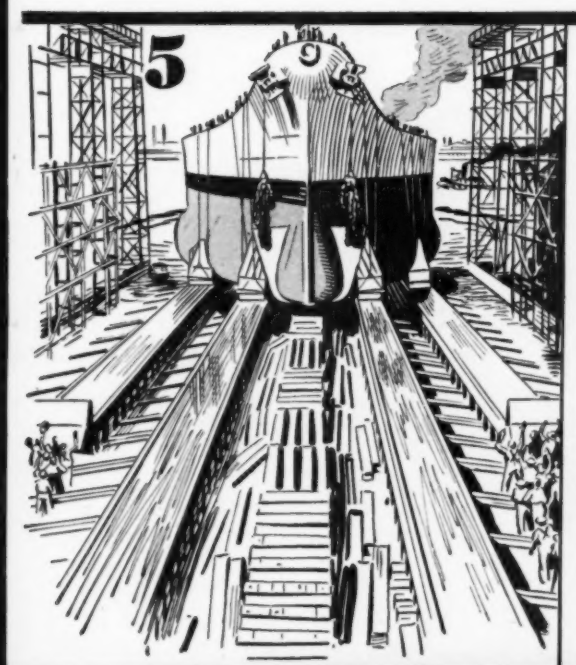


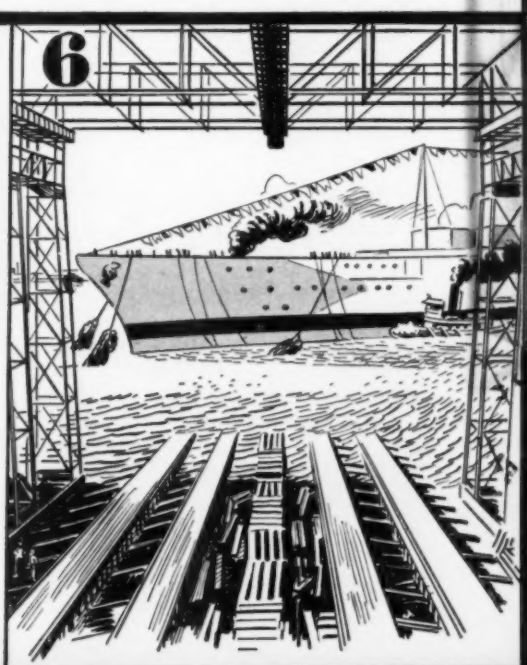
With the immense weight of the ship removed from the keel blocks, they are taken out, along with the bracing cribs and shores. Here our artist offers his conception of the scene as the workmen are lifting the large, heavy timbers out of the way

All that now prevents the ship from sliding down the greased ways is a group of steel tie plates which anchor the sliding ways to the fixed ground ways. When these have been cut through with a torch, the ship starts stern first down toward the water

This is the dramatic moment of a launching, as the huge hull slides down the ways, steadily gaining momentum. Smaller ships usually are launched on one pair of ways, but a vessel of 45,000 tons requires four ways, not only to support the immense weight but also to prevent the hull from toppling sideways

Once the hull is in the water, coils of chain are dropped so that they trail and brake the sternward motion. When the hull comes to a stop, tugs take over the job of moving it to the fitting-out basin where the superstructure, guns, and fittings are installed and the ship is made ready for service





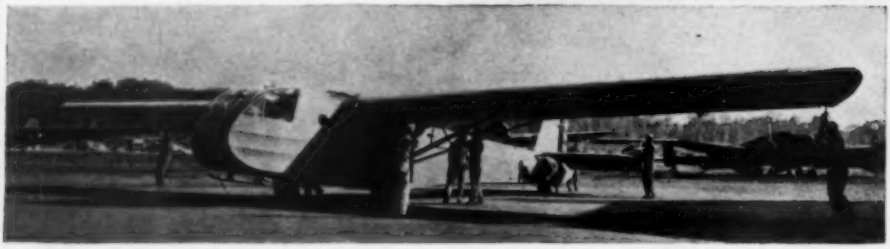
"Slip Covers" for Tires

"SLIP COVERS" that fit over worn car tires, developed by Martin Castricum of the United States Rubber Company, offer a new answer to the problem of rubber scarcity. Woven of cotton pile like bath-mat material, and treated with asphalt emulsion, they are said to add from 2,500 to 3,000 miles of life to old shoes. Their makers recommend having a competent tire-service man apply them; carrying 40 pounds of pressure in the tires; and limiting speed to 30 miles an hour. Admittedly a makeshift, the slip covers will nevertheless keep a car going, and production plans call for their immediate manufacture in popular sizes for passenger vehicles. Further research is expected to yield a material suitable for use on the tires of light delivery trucks.

Army Invasion Glider Carries 13 Soldiers and Two Pilots

DESIGNED to take a leading part among invasion forces, the U. S. Army's new "Commando" troop-carrying glider spells bad luck for the enemy. Besides the pilot and copilot, it carries 13 fully equipped troops into action. Towed by a twin-motor plane, two or more of the craft may be cut loose and landed in a small field or pasture. Unconventional features include an overhead attachment for the towline, and take-off wheels that are dropped in midair for a landing on skids. Measuring 83 feet in wing span, more than many fighting planes, the heavy-duty glider scarcely exceeds 3,000 pounds in weight. The new glider, called the CG-4A, is now in quantity production for the armed forces.

Attachment of the towline at top of fuselage, as seen at right, is a new feature. Below is the roomy cockpit. Note control panel



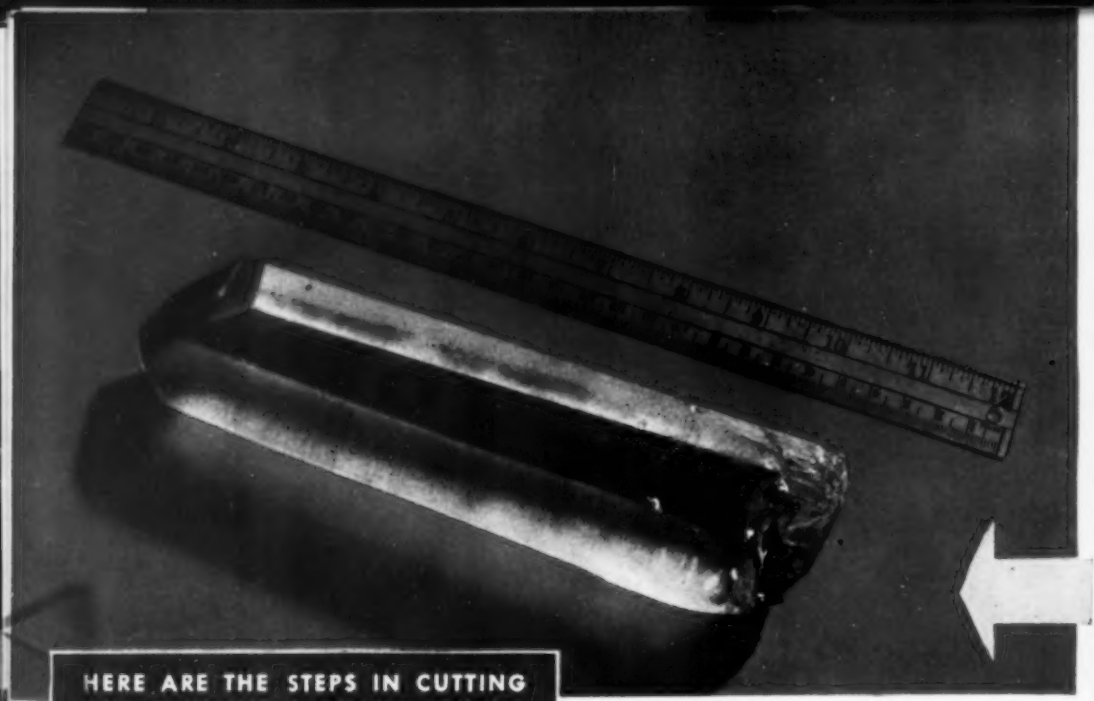
On the ground, the huge motorless craft looks like a transport plane, with its wing span of 83 feet. Wheels used in taking off are dropped after the 3,000-pound glider rises. Landing is made on skids

Tail Brake on DO-217E Controls Its Diving Speed

ELECTRIC SCREW JACK EXTENDS VANES OF DROGUE TO PREVENT EXCESSIVE DIVING SPEED
SLOTTED FINS PREVENT RUDDER STALL WHEN FLYING ON ONE ENGINE
TABS OPERATED BY SOLENOID PLUNGERS CONTROL ELEVATORS IN DIVE
FOLDED DROGUE
DETACHES HERE
SLOT
COCKPIT COVER ON TOP OF NOSE AT WING'S FRONT EDGE CARRIES TWO 7.92-MM. MACHINE GUNS
COLLAPSIBLE RUBBER BOAT IN ARMORED RECEPTACLE
BOMB BAY DOORS
FLAME-ARRESTING EXHAUST PIPES FOR NIGHT FLYING
1,580-H.P., 14-CYLINDER, AIR-COOLED, TWO-ROW RADIAL ENGINE
7.92-MM. MACHINE GUNS
7.92-MM. MACHINE GUN
FIXED 15-MM. CANNON
MOVABLE 20-MM. CANNON
STEWART HOUSE

Hitler's new DO-217E checks dive-bombing speed with a tail brake. It can also drop torpedoes and lay mines

CHIEF among the features of Germany's new Dornier dive bomber, the DO-217E—one of which has been taken in good enough condition for study—is its dive-braking arrangement, transferred from under the wings to the tail. This drogue, as it is called, consists of a series of radial vanes which act as brake surfaces and open on an electric screw jack. The tail can be jettisoned if damaged, and may be removed and an orthodox tail substituted for level bombing. In fact, the DO-217E is designed for torpedo-bombing and mine-laying as well as diving. It is equipped with three bomb-bay doors, the rear one of which is an auxiliary to provide an opening large enough for a torpedo.



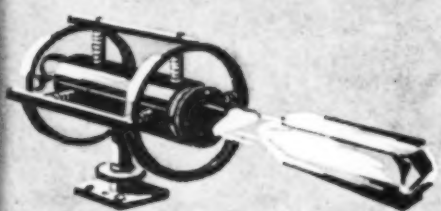
HERE ARE THE STEPS IN CUTTING AND GRINDING A QUARTZ CRYSTAL

Quartz

Finely Ground Crystal Wafers Make Our Modern Methods of Communication Possible

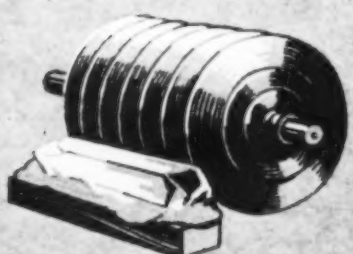
AN ATOM of silicon, going about its submicroscopic business a few million years ago, felt the allure of a pair of oxygen atoms, and since the attraction was mutual, the three united to form a single molecule called silicon dioxide (SiO_2). Similar atoms, yielding to the same cosmic compulsion, followed their example, and countless molecules ar-

ARC-LIGHT EXAMINATION



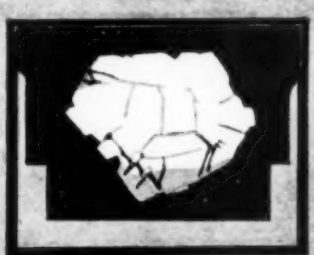
Raw Brazilian quartz crystals are examined under an arc lamp for minute flaws. So many defects appear in the highest grade that a relatively small percentage of the new material can be used

FIRST CUTTING

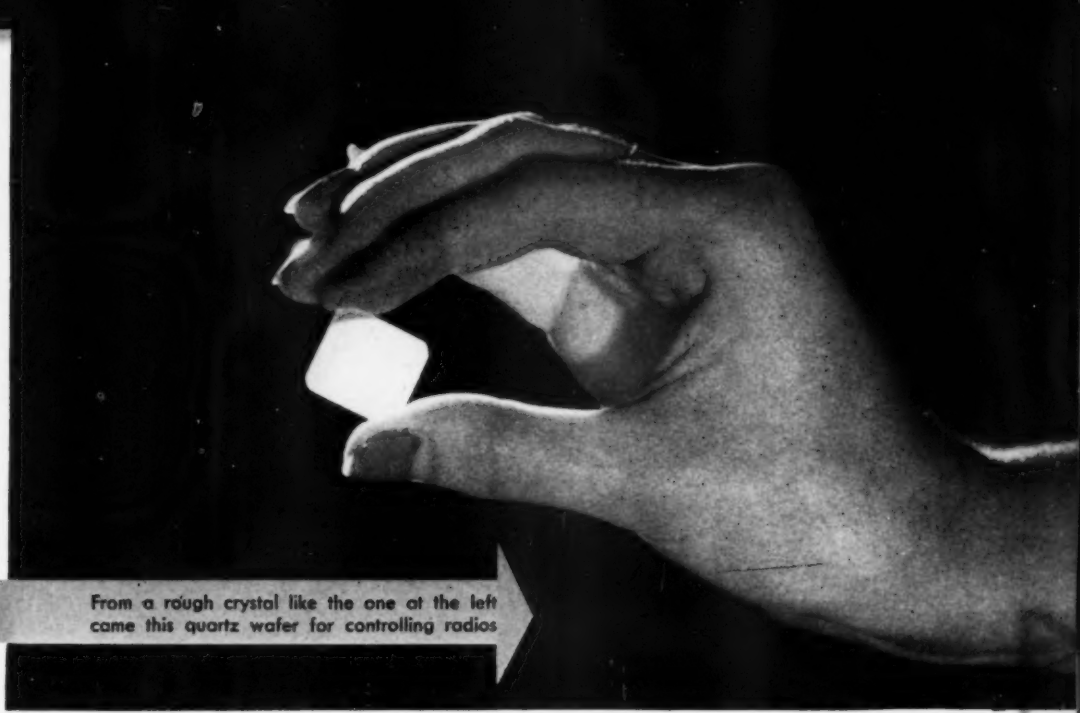


Pieces of quartz are mounted on wood with plaster of Paris and machine cut into hexagonal blanks at approximately the desired angle. Parts that were marked defective in the examination are discarded

POLARIZATION



Retained blanks are again inspected—this time with polarized light which may reveal "twinning," a slight fault which may not prevent oscillation, but will impair performance at some temperature



From a rough crystal like the one at the left came this quartz wafer for controlling radios

Gives Radio Sharper Ears

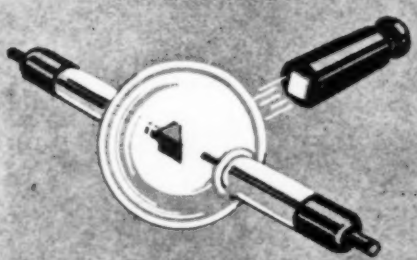
ranged themselves in proper fashion to form crystals of mother quartz.

Today a slice of one of these crystals, about the size of a postage stamp, makes it possible to tune a radio to a station and keep it there. Mounted in a holder between two metal electrodes, vibrating from 20,000 to 20,000,000 times a second according to cut and thickness, the wafer controls the vacuum-tube oscillator circuit and holds radio frequencies constant within 0.0001 of one degree. It predetermines the setting of military radio transmitters, and through recent improvements permits aircraft communication at all temperatures.

The secret of the crystal's power lies in its possession of the electromechanical property known as piezoelectricity—electricity or electric polarity due to pressure—discovered in 1880, but forced to wait for practical application until the discovery of the electron and the invention of the electronic vacuum tube. Its first use was in submarine detectors in 1917.

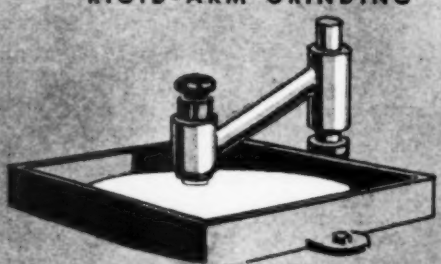
Natural quartz imported from Brazil, which supplies the material used by most manufacturers of crystals, is usually clear and colorless. The pyramidal type is the most common form. Its faces, some almost optically flat, are polished and bear marks resembling those of a cutting tool.

ORIENTATION



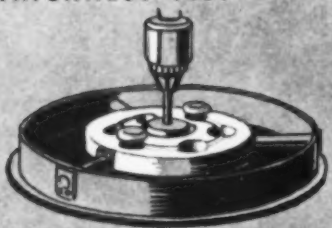
After cleaning and conditioning, blanks are set in adjustable fixtures so that their faces may be oriented accurately by X-rays. This insures constant frequency regardless of temperature

RIGID-ARM GRINDING



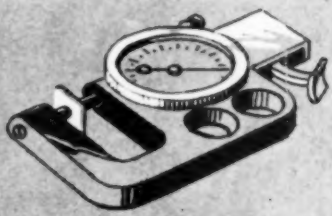
With the correct reference face established by X-rays, each crystal, still held at the base of the adjustable fixture, is ground to a precise plane on a manually operated grinder spindle

THICKNESS TEST



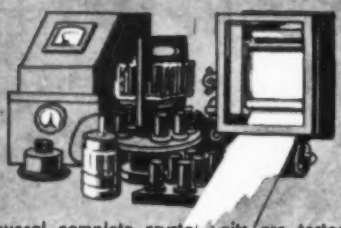
Preliminary to hand finishing, thickness is reduced by parallel grinding on time-switch lapping machines which hold eight crystals

PARALLEL GRINDING



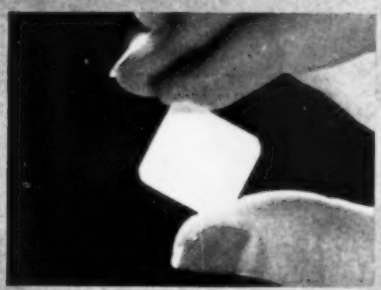
Should performance on the finisher's desk cause doubts, a crystal's parallelism is checked carefully with a thickness gauge

FINAL TEST



Several complete crystal units are tested at the same time in a crystal circuit for performance over a wide temperature range

FINISHED CRYSTAL



In manufacture everything depends upon thickness, precision of grinding, and angle of cutting. All crystals up to about 1926 were cut parallel to the faces of the mother quartz, but they had high temperature coefficients, were subject to changes in vibration, and had to be housed in constant-temperature boxes. This bulky equipment was abandoned about 1935 when the Bell Telephone Laboratories and the Radio Corporation of America began cutting at an angle, producing crystals with a temperature coefficient as low as 0.0001 percent per degree centigrade, which could maintain transmitter frequency between minus 30 and plus 60 degrees without temperature control. They were of enormous importance in the development of aircraft communication, the efficiency of which was further increased when the General Electric Company developed a hermetically sealed holder to conquer one of the quartz crystal's greatest foes, moisture.

Because of the hardness of quartz special cutting methods are used, most of them with abrasive disks and plates, but the final finishing must be done by hand. The first step is inspection of the raw quartz under a strong arc light for flaws. These are marked, and the crystal cut by parallel saws so as to eliminate them. The resulting hexagonal sections are examined under polarized light to expose "twinning." Quartz is twinned when the rotary polarization is both clockwise and counterclockwise. This reduces life or impairs performance. All twinned quartz is discarded, and the remaining sections are machine cut into bars which in turn are cut into thin slices.

These blanks are cleaned and conditioned. Then adjustable fixtures hold them under X-ray reflection for orientation to a position that will result in accurately oriented faces. Still attached to the fixture, an oriented blank is placed in a rigid-arm grinder, and one face ground to the correct plane. About fifty thus ground are placed on plates and put through a surface grinder. They emerge parallel and approximately the correct thickness, and are ready for a precision lapping machine controlled by a time switch.

The finisher first makes tests to determine if piezoelectric activity is normal, then to show how much the crystal must be lapped to bring it to the designated frequency. In most cases it will be between 0.0005 and 0.0001 inch. This requires great skill, and is done by the cut-and-try method. Final tests for accuracy are made after the crystals have left the finisher.

Un-Natural History

BY *Gus Mager*

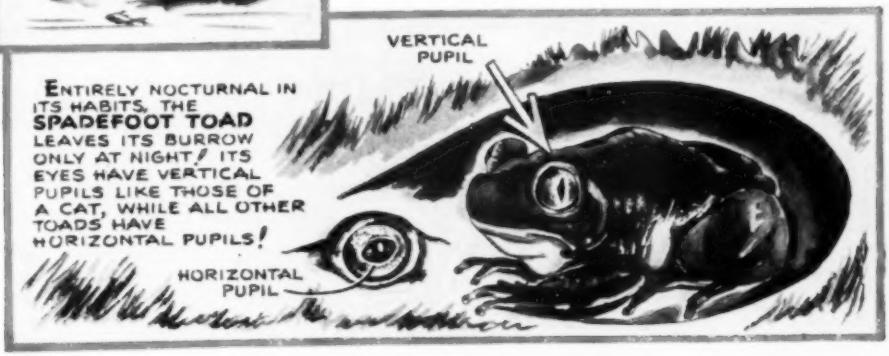
DRAGONFLIES ARE MARVELOUSLY EFFICIENT FLYING MACHINES, BUT IN SPITE OF THEIR SIX LEGS THEY CANNOT WALK!

THAT MONSTROUS FALSE EYE IN THE RUMP OF THE **SPHINX MOTH CATERPILLAR** IS ENOUGH TO SCARE ANYBODY WHO COMES UPON THE BIG LARVA ON THE GRAPE ARBOR! TO MAKE MATTERS WORSE, THE CATERPILLAR SQUIRMS VIOLENTLY FROM SIDE TO SIDE TO THE ACCOMPANIMENT OF A FRIGHTFUL SQUEAK!

THE **CORMORANT** FOUND IN PERU DIFFERS FROM ALL OTHER CORMORANTS IN ITS FEEDING HABITS. INSTEAD OF DIVING FOR FISH FROM THE SURFACE, IT HUNTS ITS PREY FROM THE AIR AND THEN DIVES AFTER IT!

WHEN THE AUSTRALIAN **WOMBAT** ENCOUNTERS A RIVER IN ITS TRAVELS, IT WALKS RIGHT INTO THE WATER AND ACROSS ON THE BOTTOM OF THE STREAM!

ENTIRELY NOCTURNAL IN ITS HABITS, THE **SPADEFOOT TOAD** LEAVES ITS BURROW ONLY AT NIGHT! ITS EYES HAVE VERTICAL PUPILS LIKE THOSE OF A CAT, WHILE ALL OTHER TOADS HAVE HORIZONTAL PUPILS!



SOME INSIDE FACTS ABOUT

CIPHERS: Secret Language Of War

SAFEGUARDING military correspondence is a task that has tested the ingenuity of men from ancient times. Great battles have been lost through dispatches falling into the hands of the enemy. The oldest known precaution against this was the scytale used by Greek generals, a wooden rod around which was wound a ribbon of parchment and the message written across lengthwise. When the parchment was unwound, its message could be read only by wrapping it around a similar rod.

Ciphers that have been used in more modern times fall into three main classifications: Concealment, substitution, and transposition. The spy resorts to concealment. His life may depend upon his message not being detected as a cipher. He may mail a piece of printed matter with pin pricks under certain letters spelling out a long message of vital information.

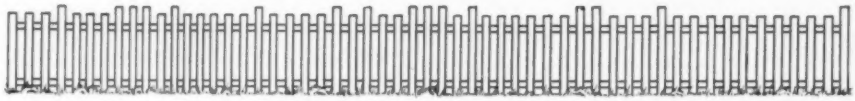
The "grille" is one of the spy's favorite methods of concealment. Its invention is attributed to the crafty French statesman of the 17th century, Cardinal Richelieu. A sheet of paper or cardboard of the size of standard sheets of note or letter paper has rectangular perforations so that words may be written through them onto the standard sheet. The sheet is then filled up with what appears to be an innocent letter in which the words of the secret message in their proper position are cleverly woven into the sentences. The recipient lays his similar grille over it to get the secret meaning.

The substitution cipher is very ancient in

VIGINERE CIPHER. Here a message has been put into one of the "multiple-alphabet" ciphers with the keyword "SPY." Each letter in the message is replaced by the corresponding letter in one of the "Caesarian" alphabets, depending upon which letter of the keyword has been written under it

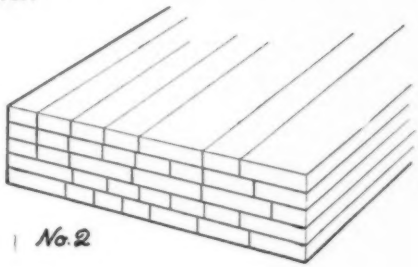
TEN TRANSPORTS SAIL TODAY
SPY SPYSPYSPYS PYSP YSPYS
CODE
PLAINTEXT ALPHABET
A B C D E F G H I J K L M N O P Q R S T U V W X Y Z
CAESARIAN ALPHABETS
S T U V W X Y Z A B C D E F G H I J K L M N O P Q R
P Q R S T U V W X Y Z A B C D E F G H I J K L M N O
Y Z A B C D E F G H I J K L M N O P Q R S T U V W X
LTL LGYFHNGGRK HYAA RGSYQ

CAN YOU DECIPHER THESE HIDDEN MESSAGES?

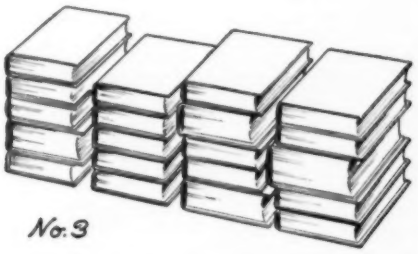


No. 1

THESE drawings of a picket fence, a pile of lumber, and a stack of books convey messages in the famous Baconian cipher. Can you decipher them? Here's a hint: they are based on the "Baconian alphabet" below. In the fence, short pickets are a's, long ones b's; in the lumber, narrow boards are a's, wide ones b's; in the books, thin ones are a's, thick ones b's. Answers are given on page 89. This way, spies can send messages in innocent-looking pictures.



No. 2



No. 3

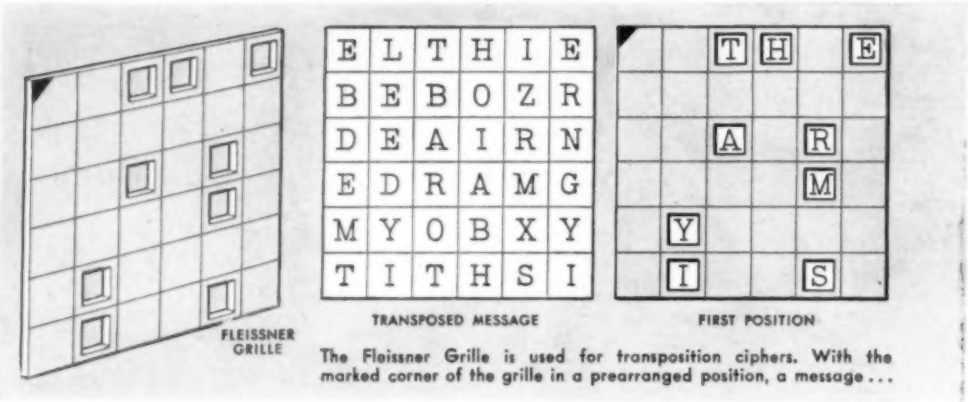
BACONIAN ALPHABET

A.	aaaaa	I J.	abaaa	R.	baaaa
B.	aaaab	K.	abaab	S.	baaab
C.	aaaba	L.	ababa	T.	baaba
D.	aaabb	M.	ababb	U V.	baabb
E.	aabaa	N.	abbaa	W.	babaa
F.	aabab	O.	abbab	X.	babab
G.	aabba	P.	abbba	Y.	babba
H.	aabbb	Q.	abbbb	Z.	babbb

origin and the spy can disguise its real character in numberless ways. Essentially it is the substitution of other words or characters for the letters of the alphabet. A B C . . . may be represented by Z Y X . . . where Z always represents A, Y always represents B, and so on to the end of the alphabet. Our childhood's favorite, the so-called "Masonic" cipher, is an example where characters are used. The plot of Poe's "Gold Bug" is based on the substitution cipher, as well as Doyle's story of the "Dancing Men." Simple substitution is so easy to solve that it is a popular amusement at the present day and many newspapers published a cryptogram along with the crossword puzzle.

The famous Baconian cipher belongs to the substitution class and is the parent of similar systems. Bacon used only *a* and *b* in combinations of five and it is consequently called "biliteral." Thus A=aaaaa B=aaaab C=aaaba D=aaabb E=aabaa F=aabab G=aabba H=aabbb IJ=abaaa K=abaab etc. In printed matter, if two styles of type are used, one for the a's and one for the b's, any book may be published and convey information which it is desired to keep secret. Five letters of the printed matter will represent one Baconian letter. Thus, "Po*pul*/ar*Sci*/enc*eM*/on*thl*/y*hasm*/a*nyre*/ad*ers*" conveys the words "hide jig." The letters in ordinary type are a's and those in italics b's. The letters are run together and separated in groups of five only to make it clear to the reader. Any ordinary printed matter, no matter in what type printed, may be used, by adopting the puncture system or some similar method to distinguish the a's from the b's. This cipher may also be used pictorially. A pile of lumber, a picket fence, or stacks of books may carry a message. Narrow boards are a's and wide ones b's. Instead of this biliteral type, triliteral ways have been devised which would require only three letters in combination in place of five.

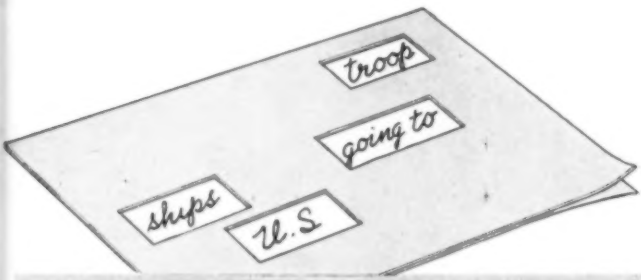
The transposition cipher transposes the letters of a message according to some prearranged system. Here we meet with the grille again as one of these systems. Colonel Fleissner, an Austrian, perfected one which is described by Jules Verne in his story "Mathias Sandorf." It is a square of any even number of cells. Certain cells have apertures so chosen that when the square



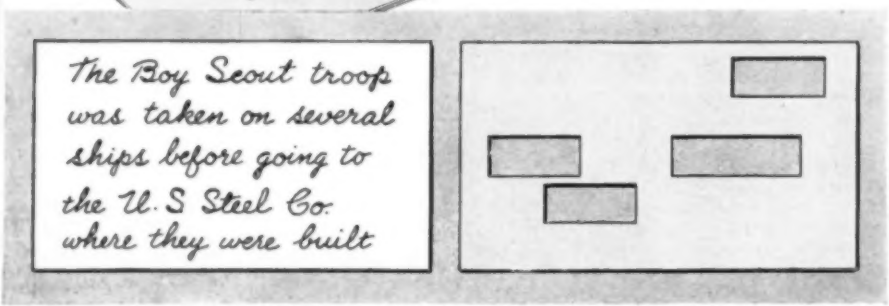
The Fleissner Grille is used for transposition ciphers. With the marked corner of the grille in a prearranged position, a message . . .

grille is turned clockwise into the four possible positions, letters having been written through the apertures each time, all the cells will be filled. If the message does not use up all the apertures they may be filled in with infrequent letters called "nulls." The illustration with the upper left-hand corner marked for the first position will make its use clear. After the square is filled up the message may be taken off in different ways, but if horizontally from the top it would be ELTHI EBEBO ZRDEA IRNED RAMGM YOBXY TITHS I. It is customary to write ciphers in words of five letters. The recipient puts the letters into the 36 cells in the order agreed upon and then applies the grille to decipher the message. Different perforations than those shown are possible.

Another way of entering the letters of a message into a square is to agree upon a certain "magic square." Magic squares are made up of numbers that add up to the same sum vertically, horizontally, and diagonally. They may be of any size, according to the length of messages likely to be sent. But one would have to be agreed upon because many different magic squares may be formed with the same number of cells. The example

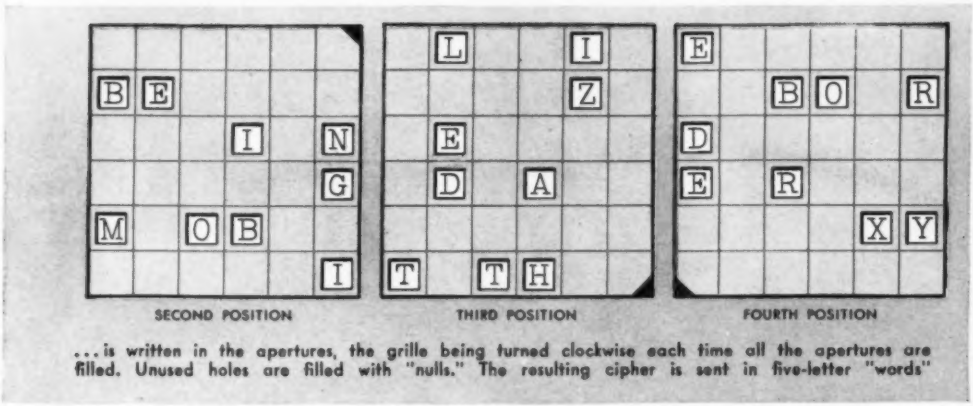


RICHELIEU'S GRILLE
This device is a favorite with spies. A mask with rectangular perforations is laid over a piece of writing paper and the message is written in the openings. Then the mask is removed and the letter is cleverly filled in with words that will make it seem harmless



The result is an innocent-looking note. This is a concealment device (cannot be recognized as cipher)

At the receiving end, the spy's correspondent lays a similar mask over the letter to read the message



...is written in the apertures, the grille being turned clockwise each time all the apertures are filled. Unused holes are filled with "nulls." The resulting cipher is sent in five-letter "words"

shows one of five cells which is "perfect" in that even the broken diagonals add up to 65, i.e., their complementary portions, as 12-6-5-24-18.

1	17	8	24	15	T	L	S	H	A
9	25	11	2	18	P	Q	R	E	T
12	3	19	10	21	T	N	O	O	A
20	6	22	13	4	D	A	Y	S	T
23	14	5	16	7	G	S	R	I	N

The message TEN TRANSPORTS SAIL TODAY has the letters written into the square according to the numbered cells as shown. It is then taken off as in the case with the grille. The recipient puts them into the square in the way agreed upon and then picks out the message according to the numbers of the magic square. "Nulls" fill up vacant cells.

Still another method is to number the squares of the chess board according to the solution of the "Knight's Tour."

The most usual way is simply to write the letters in the form of a rectangle, though other geometrical forms may be used. The same message as above then takes this form:

T	E	N	T	R
A	N	S	P	O
R	T	S	S	A
I	L	T	O	D
A	Y	G	H	Q

The message may be taken off as TARIA YLTNE NSSTG HOSPT ROADQ, or QDAOR TPSOH GTSSN ENTLY AIRAT, or in any manner predetermined between the writer and his correspondent.

As a single-transposition cipher has in it the actual letters of the message, short ones may often be solved expeditiously, regardless of the system used, by cutting little squares of cardboard, as many as there are letters, and putting the letters upon them, one to each piece. These are juggled around to form words and sentences and one is pretty apt to hit upon the right sentence after a number of trials. "Puzzlers" solve anagrams in this way. Longer ciphers must be solved in a more scientific manner.

There is a large class of "multiple alphabet" ciphers. The best known of these are the "Gronsfeld," "Viginere," "Variant," and "Beaufort." In these a system is used such that A, for instance, may be represented by many other letters of the alphabet in the same message instead of by one only as in simple substitution.

The "Gronsfeld" was formerly used in France and also was used by Jules Verne as the basis for a story. A number is taken as the key, say 2546. This is written repeatedly under the "plaintext" message:

TEN	TRANSPORTS	SAIL	TODAY	Plaintext
254	62546254 62	5462	54625	Key
VJR	ZTFRYRTVZU	XEON	YSJCD	Cipher

The 2nd letter *after* T is taken (V), the 5th letter after E (J) and so on. The message is sent VJRZT FRYRT VZUXE ONYSJ CD. The recipient reverses the process to get the message, taking the 2nd letter *before* V, etc.

The Viginere takes a keyword instead of a number and adopts a "Caesarian" alphabet for each letter of the keyword. This is illustrated on page 86 with the short keyword "spy."

Every letter with S under it is coded from the S alphabet; thus T is L, N is F, etc. Every letter with P under it is coded from the P alphabet, and every letter with Y

(Continued on page 222)

ANSWERS

to ciphers on page 87

1. CHIEF HID CAB

2. BID HIGH

3. CAKE

Two of a kind: The Army's new ¾-ton truck (as a weapons carrier) is seen at the right, beside the new Jeep to which it has a close family resemblance

The JEEP Gets a *Big Brother*

THREE-QUARTER-TON IS TOPS IN ARMY TRUCKS

THAT amazing little Army Jeep is all but bursting its leakproof body seams with pride, for it has a brand-new big brother that is a honey. The new arrival bears enough family resemblances to the Jeep to justify the pride. But it also has some Army mule in it, mixed with various other animal qualities that give it mobility in every climate and terrain. The step of a camel in soft sand, for example; the low silhouette of a cat, and the agility of a kangaroo. It is the Army's new three-quarter-ton truck.

It is as warlike as the newest fighting plane. It is as purely military as the Jeep. It was designed, refined, tested, and proved by the Quartermaster Corps engineers at the Motor Transport Service Base near Baltimore, with the co-operation of Dodge truck specialists. The Quartermasters, it will be remembered, also wrought the Jeep out of nothing more than a sound idea. It is a true

Command and Reconnaissance

Weapons Carrier

Some of the Jeep's jack-rabbit blood seems to have got into its big brother. Note the wide tread and high road clearance—the latter combined with the lowest silhouette of any Army car except the Jeep itself

big brother to the Jeep—bigger, stronger, with high road clearance, wide tread, splendid fordability of streams, and great tractive power through its "high flotation" tires.

In a single stroke, it has advanced beyond any previous undertaking three of the Army's most ambitious plans for its tactical vehicles: All-military design, reduction in number of chassis types, and standardization (interchangeability) of parts. It is in volume production today. Four body types are built on its squatly efficient frame, so that it appears as a weapons carrier (small guns, ammunition, machine guns), a command and reconnaissance car (for officers, scouts, liaison), a carryall (supplies, equipment, general field utility), and ambulance. And make no mistake: It is not a behind-the-lines vehicle. It is for use on the fighting fronts as a tactical vehicle!

Each of the four bodies has been used on the Army's familiar half-ton truck. In each, however, the three-quarter-ton vehicle has permitted refinements that fit the bodies better for their assignments. Thus the new weapons carrier, from most viewing angles, bears little resemblance to its half-ton predecessor. Side-on, it has lost inches in height. End-on, it is wider, the space over the rear wheels now being used for seats where it was once not used for anything. And though you have seen soldiers packed like sardines in the half-tonners, if they were sitting at all they were using temporary benches. The longitudinal seats on the new vehicle have backs that fold down when not in use, and the seats themselves, which hold eight men, open up revealing spacious compartments fore and aft of each rear wheel for ammunition, grenades, tire chains, and accessories.

Side indentations behind and before the rear wheels give protection from sideswipes to rope hooks for the tarpaulin tops, or for lashing down materiel, and also protect a flush-mounted gasoline-tank filler pipe. On the short running board to the right of the

Carryall

Ambulance

How the three-quarter stacks up beside the vehicle it replaces: the half-ton, here also a weapons carrier

driver's seat, two five-gallon gasoline cans fit in holders to supplement the 30-gallon main tank at the rear. On the hinged tailboard, rather than inboard as formerly, the inevitable ax and shovel are mounted on permanent brackets. On the front of this fighting vehicle a power-driven winch just behind a heavy, split-type front bumper gives the truck the ability to lift itself by its own bootstraps out of the few muck holes and up the occasional grade tough enough to stop it.

The new command and reconnaissance body likewise boasts a low silhouette from end to end. Like the new carryall—the Army's bullish, steel equivalent of the station wagon—it comes with a 12-volt electrical system, and on both these vehicles the battery is in a separate case on the right running board, providing ample power for either standard or frequency-modulation radio. Both also have permanently built-in antenna brackets mounted on the side opposite the battery. Behind the carryall's rear seat is a full-width compartment for radio equipment, ammunition, small weapons, and supplies.

The most viciously designed pothole at the Motor Transport test base, where the three-quarter-tonner

FRONT. From this angle, the two vehicles show little resemblance. The new car is much wider, space over the rear wheels being used for seating and storage space instead of being wasted. The power-driven winch enables it to pull itself out of a hole

REAR. Here the additional width is very apparent. Four soldiers can sit on either side, on permanent longitudinal seats. With the half-ton, men sit on temporary benches and have much less footroom. Tail lights are recessed on the three-quarter; pioneer kit is packed at the rear

spent months proving its ability to take it, neither stops nor wrecks the new ambulance. And while it will withstand perhaps much more punishment than severely wounded soldiers can, it is good to know that in the pinches it will get up to the front lines where it is needed. Again wider and lower than its predecessor, the ambulance carries four litters. It makes better use than any of the new three-quarter-tonners of redesigned shock absorbers and springs that improve riding quality and add to the comfort of passengers. Here, too, the better shock absorption of the larger tires adds comfort to the quality of good traction.

You should understand what the Army means by "tactical vehicle." Make no mistake about the name. This breed of cat goes up to the fighting lines with troops, and some of them fight in their own capacity as machine-gun carriers and antiaircraft and antitank-gun prime movers. They are wheeled trucks, not tanks or endless-tread vehicles carrying heavy armor, though some

FORDABILITY of a high order is assured by careful placing of the carburetor air intake and oil filler pipe. Radiator-fan bearings are several inches higher than on the half-ton to prevent splashing of water

In racks on the running board at the right of the driver's seat ride two five-gallon gasoline cans for a reserve fuel supply

Seat backs fold when not in use. Seats lift up to uncover wells forward and aft of rear-wheel housing. These can be used to hold ammunition, grenades, tire chains, and other articles

A CAMEL'S FOOT is nature's design for best support on shifting sand. Engineers call it "high flotation." The ¾-ton gets it by using 9-by-16-inch tires, compared in the photograph with the 7:50 by 16's used on the half-ton vehicle

of the six-wheelers may be fitted with endless treads. They are the vehicles that are used by combat divisions and their supporting guns.

A glance at the roster of tactical trucks in the Army today spotlights the value of the new three-quarter-tonners. These are the quarter-ton (Jeep), half-ton, three-quarter-ton, 1½-ton, 2½-ton, four-ton, and six-ton. They are all in the province of the Quartermasters to design, buy, supply, service, and repair. (You should include the 7½-ton truck as a tactical vehicle too when it is employed as a prime mover for long-range supporting artillery.) All of these tactical vehicles of the Army Quartermasters have all-wheel drives, their front wheels being engaged or disengaged from the drive mechanism at will.

So effective is the new truck that it has brought to an abrupt end the manufacture of half-ton trucks, the duties of which it takes over lock, stock and barrel. It may even push the 1½-ton truck out of the picture. So, although existing half and 1½-tonners will not by any means be junked, the tactical trucks and their duties will ultimately line up as follows:

Quarter-ton: 4 x 4 (four wheels, four-wheel drive), one model—reconnaissance and command.

Three-quarter ton: 4 x 4, four models—weapons carrier with power winch, command and reconnaissance, carryall, and ambulance. The weapons carrier is a prime mover (towing unit) for the 37-mm. antitank gun, and also may be a self-propelled 37-mm. gun mount as shown in the drawing on page 96.

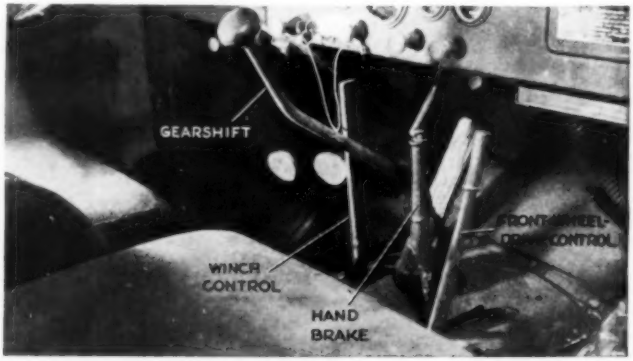
Two-and-a-half-ton: 6 x 6, two models on long and short wheelbases with and without winches. The long-wheelbase unit is a cargo or personnel vehicle, a 1½-ton wrecker, or a 750-gallon tank truck. The short-wheelbase unit is a prime mover for the 37-mm. antiaircraft gun, the 40-mm. Bofors antiaircraft gun, the 75-mm. gun, or the 105-mm. howitzer.

Four-ton: 6 x 6, prime mover for 155-mm. howitzer (largest gun in triangular division), and the big Quartermaster Corps wrecker.

Six-ton: 6 x 6, prime mover for 3-inch antiaircraft Coast Artillery gun and the 90-mm. antiaircraft gun.

Seven-and-a-half-ton: 6 x 6, prime mover for 240-mm. howitzer, the 8-inch howitzer, and 155-mm. rifle.

CONTROLS are simplicity itself. Regulation dashboard instruments include a speedometer with odometer, ammeter, engine-temperature indicator, pressure gauge for oil, fuel gauge, ignition and light switches. The speedometer has a luminous indicator hand and 10 and 20-mile markers to help blacked-out convoys hold pace



The Quartermaster vehicles are built by: Jeep—Ford and Willys; three-quarter-ton—Fargo (Dodge truck sales division of Chrysler); 2½-ton—G.M.C., International, and Studebaker; four-ton—Diamond-T; and six-ton—White and Corbitt.

How neatly the newest tactical vehicle fits into this picture gains best emphasis by comparing it with the half-tonner. Both are 4 x 4's, with the same engine, and come in the same four body types. There the important similarities end. Let's look at the old and new wheelbases for the four body types. This table shows how they stack up:

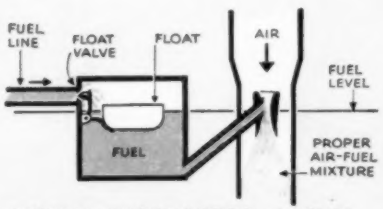
	Old	*New*
Weapons carrier	116″	98″
Command car	116″	98″
Carryall	116″	114″
Ambulance	122″	121″

This shorter wheelbase in every model adds mobility on rough ground, shortens the turning radius, and improves handling. Where the half-tonner had a tread narrower by several inches in front than at the rear—an old commercial-truck practice—the new

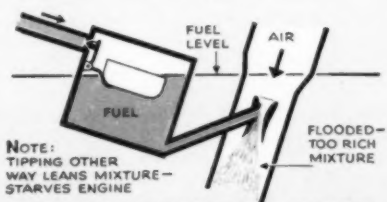
A recess guards the flush-mounted gasoline-tank filler pipe. Similar treatment prevents sideswiping of the rope hooks used in fastening down the tarpaulin top and in lashing truck cargoes

Tip-Proof Carburetor

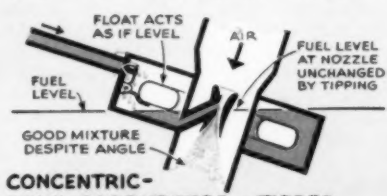
Acrobatics of Army trucks can cause trouble with ordinary carburetors by upsetting the fuel level in the bowl and flooding or starving the engine. On the ¾-ton, a new carburetor bowl encircles the intake throat, with a doughtnut-shaped float inside. The drawings below show how an ordinary carburetor reacts to extreme tipping, and how the concentric-bowl job works well at any angle



NORMAL CARBURETOR — LEVEL



NORMAL CARBURETOR—TIPPED



CONCENTRIC-BOWL CARBURETOR—TIPPED

This oil-bath air cleaner takes out more than 99 percent of the dirt and dust. Oil level rises as dirt accumulates, showing when cleaning is necessary. Wing nut below makes inspection a cinch

vehicle has equal tread width front and back so that the rear wheels follow with less effort the paths made by the front ones in snow, mud, or sand.

The wheels of this versatile go-everywhere are more attractive to a mechanically minded soldier than a week's furlough. As an enthusiastic Quartermaster engineer put it, "They are the closest things to camels' feet you could find." A camel's foot has been evolved by centuries of desert travel to give the best possible support in yielding sand. The technical term for it is "high flotation." It is what wing load is to an airplane. The more supporting area a tire (or hoof) presents to the ground, the more weight it will carry without sinking in. Tires, therefore, measuring 9 by 16 inches carry the three-quarter-tonners with easy support over sand and soft ground that would swallow up the wheels of the old half-tonners' 7:50-by-16 tires.

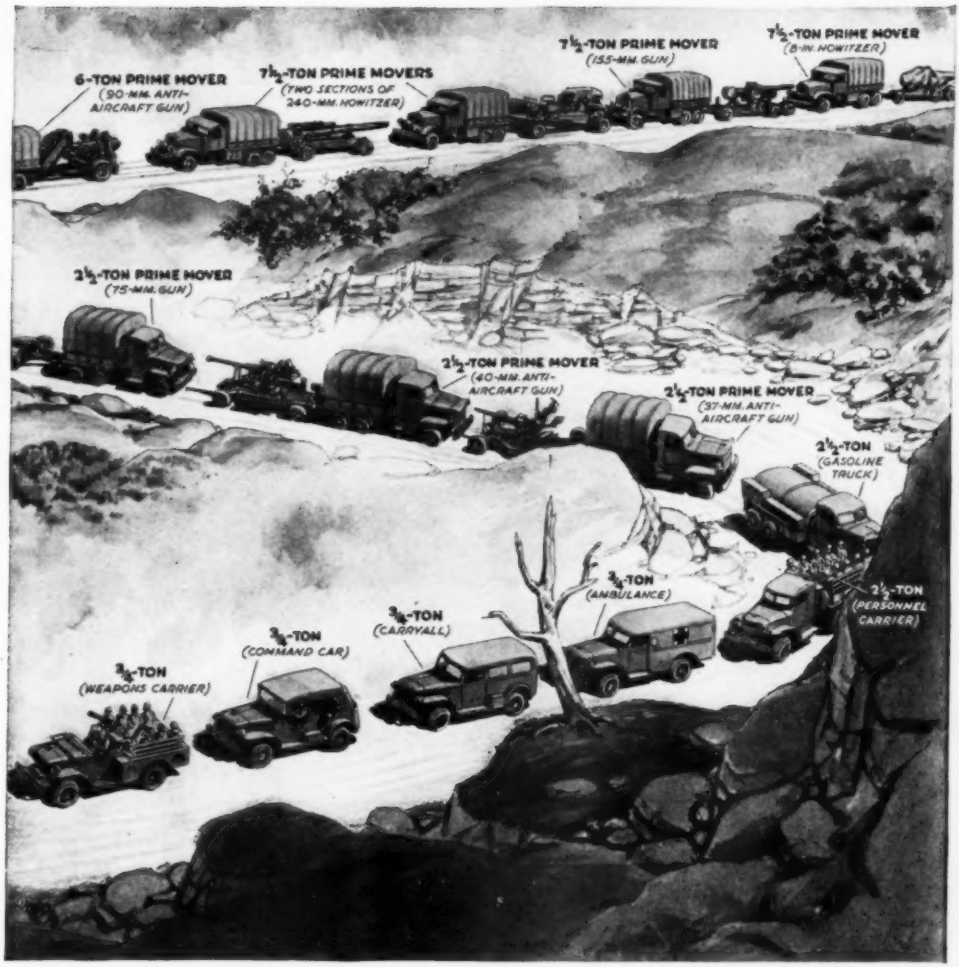
A soldier-mechanic's joy wouldn't stop there. For the brake drums dismount for brake inspection or repair without disturbing the wheel bearings, which are touchy things. A solid, removable ring circles the outside tire bead and, with an inner-bead lock, holds the tire in place by means of lugs. Remove the lugs and the tire slips off with none of the fuss and wrenching required of drop-center rims. Moreover, the tire stays in place even after a bullet or shrapnel puncture, permitting the vehicle to get out of a battle area for repairs.

The bigger tires automatically raise the axles higher for improved road clearance. The axles themselves are heavier, and such complicated parts as the constant-velocity drive joints on the front axles are larger and stronger. Differential housings are larger, too, with their ring-to-pinion-gear ratio stepped up from 4.89 to 5.83 to one, compensating for the bigger tires by giving added wheel torque. Bigger brakes are now the same size on all wheels where the half-tonner had larger ones at the back. This is made practical by nearly perfect equalization of weight on the three-quarter tonner's four wheels.

The transfer case, which distributes power to the drive shafts, also is new. Devoted to the doctrine of parts interchangeability, the Quartermasters who devised this gear case made it so that by adding a special mounting bracket it would also fit the old half-tonners, so no more special half-tonner transfer cases have to be built for replacement.

Here our artist has gathered together in one long convoy, to show aircraft support. They range in size from the ¼-ton Jeep to the propelled mount for an antitank gun, weapons carrier, command

Bigger wheels and higher axles demanded something drastic to keep the silhouette low. This turned out to be the bending of the truck frame into a new shape. The name of it is a "double-drop frame," which means humps fore and aft—rarely before used on trucks—where the heavy steel members cross the axles. Set on springs of sturdier metal, also interchangeable with the half-tonner's springs, the new truck boasts the lowest silhouette of any tactical vehicle but the midget Jeep itself. A glance at the now flat engine hood, however, only half tells the story.



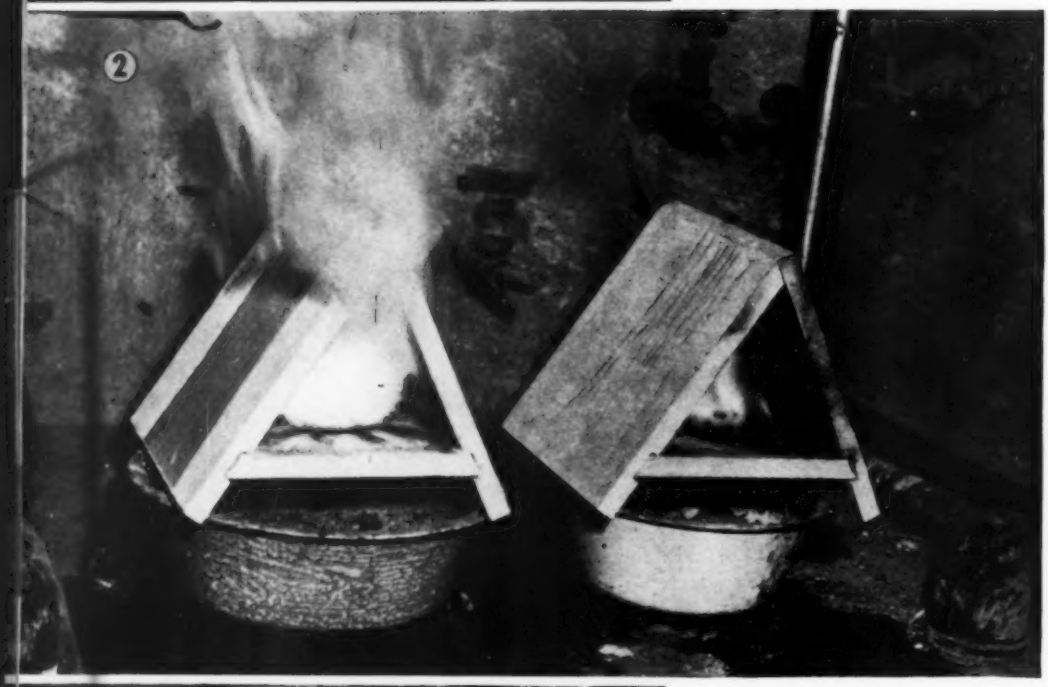
their various duties, the "tactical vehicles" used by a triangular infantry division with heavy artillery and anti-big (6 x 6) 7½-ton Ordnance truck. The six variations of the new ¾-ton truck head the line—prime mover, self- and reconnaissance car, carryall, and ambulance. They are bigger and more powerful than the old ½-ton trucks

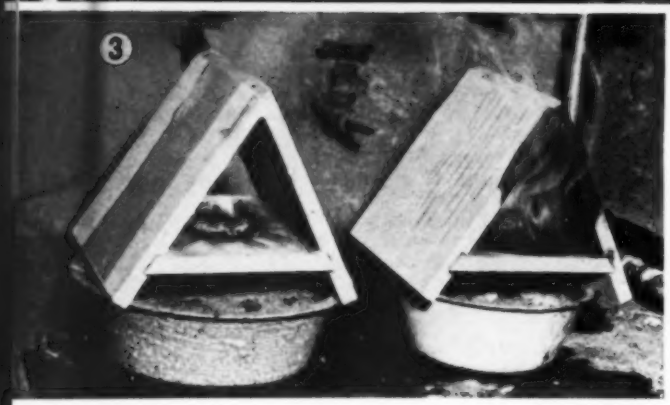
Underneath this hood, the same 230-cubic-inch Dodge engine drops into either the old or new truck as readily as a nickel into anybody's juke box, though many of the engine accessories are now redesigned to conserve space and improve performance. The radiator, formerly cellular, is now of the fin-and-tube type. If a break occurs, pinching off the broken tube repairs the leak. The cellular radiator requires removal and soldering to stop a leak. Behind this new radiator the fan whirls on bearings set several inches higher than before—an important step toward improving fordability through water. Splash from a fan will stop a truck long before the water level reaches the carburetor air intake or the oil filler pipe.

A steep grade can flood or starve a conventional carburetor, the bowl fuel level of which is maintained by a valve coupled to a float. At certain angles, the float lets in too little or too much gasoline. If too much, the gas flows too rapidly from the main jet, choking the engine. If too little, it starves it. A brand-new carburetor bowl encircles the intake throat of the carburetor in which the jet outlet is at dead center of the bowl. Thus, no matter *(Continued on page 232)*

Chemical

1 In a test of the Juda-Jones fire-retardant solution, two miniature fire bombs are placed in model attics of wood. The one on the left has been treated by brushing on two coats of the chemical; the other was not treated





2 Lighted by means of the paper strips, the two bombs explode. Difference in appearance is due to the fact that the incendiary in the untreated house happened to go off a little before the other

3 Almost immediately, the untreated structure bursts into flame as the high temperature of the bomb ignites the wood. But the bomb in the other house has practically burned itself out and the flames have not been able to gain a hold on the treated wood

Paint Protects Wood from Fire Bombs

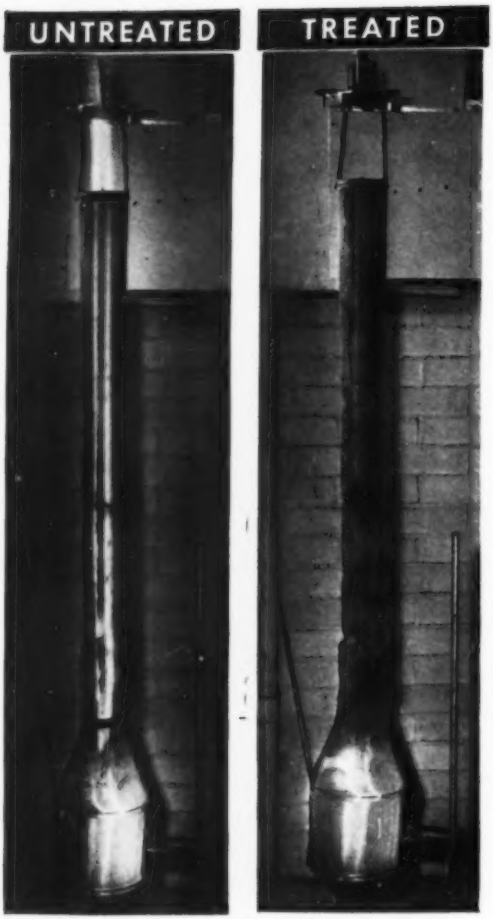
AS THE first step in demonstrating a new and remarkably efficient fire-retardant chemical, Dr. Walter Juda, research chemist at Harvard University's Mallinckrodt Laboratories, picked up half a dozen ¾-inch boards and nailed and mortised them into miniature attics approximately a foot long, a foot high, and a foot wide at the base. One of these structures he brushed with two coats of a bluish solution. The other was not treated. Both were then placed under a metal hood, and on the floor of each Dr. Juda put a paper cup containing a small incendiary bomb of 15 grams of iron and sodium peroxide, the action of which is similar to that of thermite.

When the solution had dried, the paper cups were set afire and the bombs exploded. The untreated attic burst into flames almost immediately, and within five minutes had been entirely consumed. But the structure to which the solution had been applied did not catch fire from its bomb, and for all practical purposes was undamaged. The side panels of the treated attic, hit by the first violent flare-up of flame, appeared to have been charred, but examination showed that the char was only a little deeper than the thickness of the protective coating. The structure of the wood was uninjured, although the bomb was permitted to burn until it went out, and needed only scraping and repainting to be as good as ever.

This was one of several experiments by which Dr. Juda demonstrated the new solution, which was invented by himself and Dr. Grinnell Jones, Professor of Industrial Chemistry at Harvard, and developed with the assistance of Samuel Soll. A similar test on a larger scale, involving the use of larger structures and a three-pound thermite and magnesium incendiary bomb, was recently made by the Inspection Department of the Associated Factory Mutual Fire Insurance Companies at Everett, Mass. The result of this test was exactly the same as of the experiment made by Dr. Juda in the laboratory at Harvard—the untreated attic was quickly consumed, but the treated structure was scarcely damaged. Manufactured in large quantities, the new solution could be used to protect barracks, hangars, hospitals, plywood planes, and other military installations and machines in which

4 Here's what was left of the unprotected model. It would have burned completely away if water had not been poured over it

5 The treated model, at right, is practically unharmed after the bomb is burned out. Side panels appear charred where they were hit by flame, but this is only skin deep



Hung in a screen tube, an untreated stick is completely afire two minutes after a Bunsen-burner flame is applied to the end. Treated stick is unburned at three minutes

wood is a major material employed.

Dr. Jones and Dr. Juda emphasized the fact that their solution is not a fireproofing material, but a fire retardant designed to prevent the spread of fire. Incidentally, chemists doubt that it will ever be possible actually to fireproof wood, because it is subject to destructive distillation; that is, heat alone will destroy it. Unlike the most effective of previous mixtures of this type, the Juda-Jones solution does not have to be applied by pressure impregnation. It can be put on with a brush or an ordinary spray gun. Two coats are required, and must be applied to the raw wood. Paint can be applied over it, but the two scientists have not yet determined whether it will eventually cause paint to peel or check. The experimental samples now made up are blue, but later on different colors will be obtainable, and a smooth finish will be possible, so that it can be applied, if necessary, instead of paint. As at present constituted, the solution is not applicable to fabrics, but work along this line is in progress. Dr. Jones said that the ingredients are all common chemicals of which no shortage exists, and that there is no reason why the solution cannot be produced in any desired quantity.

In another test made for the benefit of POPULAR SCIENCE readers, Dr. Juda used two sticks, one painted with the solution and the other untreated; and a tube of bronze screening about 50 inches long and three inches in diameter, with a base about six inches in diameter in which a Bunsen burner had been installed. Each stick in turn was lowered into the tube, with the end about an inch from the burner, which operated at 700 degrees centigrade. Four minutes after the burner was lighted the untreated stick had been consumed by the fire. At the end of a similar period about three inches of the treated stick had been destroyed by the heat, and about six inches of the remainder had been charred but not damaged to any great extent.

Only charcoal remains of the untreated stick. On the other, a ruler shows how far flame has reached at end of 3½ minutes

155-mm.

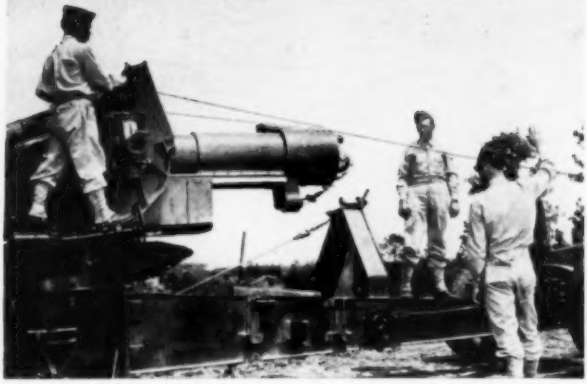
NOVEL MECHANICAL FEATURES GIVE BIG-GUN POWER, SMALL-GUN SPEED

HOW THE EQUILIBRATORS NEUTRALIZE THE MUZZLE PREPONDERANCE
PNEUMATIC CYLINDERS (ONE ON EACH SIDE) AUTOMATICALLY NEUTRALIZE OFF-BALANCE WEIGHT OF LONG PROTRUDING BARREL

THE American Army's biggest rifle on wheels, the 155-millimeter cannon, has very much the appearance of a monstrous Kentucky squirrel gun. With its exceptionally long barrel, the 155 looks unwieldly and off-balance and you wonder if the men who serve it don't have to prop up the tube with a tree in order to blast a 96-pound shell some 12 miles.

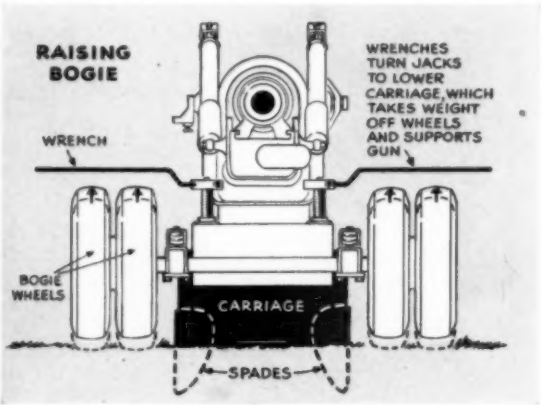
As a matter of fact, thanks to the Army's ordnance experts, the 155 is an extremely mobile and efficient weapon. Studying photographs of the gun, you notice two piston cylinders extending above the barrel, at an angle toward the breech. These are the answer to the muzzle preponderance, or pivot-

Here's the 155-mm. M1 gun limbered and coupled to its prime mover, with its crew of 15 and two drivers. At the top of the page, the big gun is "in battery," or ready for firing. Note off-balance appearance



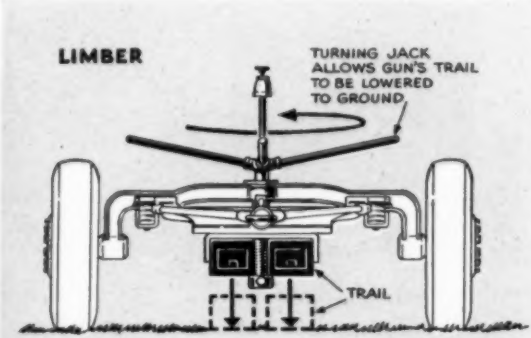
1 To put the gun in action, it is first maneuvered to point the muzzle in the desired direction. Then Nos. 1 and 2 of the gun squad disconnect air-brake lines and uncouple the drawbar of the limber from the prime mover, which pulls away on signal

2 In travel, the gun tube has been retracted so that its breech rested on a cradle. Now a cable passed over a sheave and attached to the prime mover pulls the tube forward into the firing position. This gives it high muzzle preponderance



3 Ratchet wrenches operated in unison by gun-squad members turn jack screws to lower the gun carriage to the ground. This raises the rubber-tired bogie, or weight-carrying truck, so wheels clear the ground

4 To lower the trails to the ground, a screw is turned with a mechanism resembling a ship's capstan. When the weight of the trails is removed from the limber, the latter is disengaged and rolled away



5 Four members of the gun squad spread the trails to the wide angle that gives the gun the necessary stability. Two men from the ammunition squad may help in this job, making three men to a trail

6 Spades are removed from brackets and attached to the ends of the trails, biting into pits previously dug for them. Trail logs or sandbags may be used for added stability if ground is soft

ing of the barrel back of its center of gravity.

The cylinders, for which the technical name is equilibrators, neutralize the off-balance weight of the long, protruding snout by pneumatic action. Laying the gun for elevation, the No. 3 cannoneer lifts that long barrel as easily as an orchestra leader raises his baton.

The smaller cousins of the 155 fire directly from their high-speed axles. But even though the 15 tons of big baby have eight big tires under its bogie, or weight-carrying truck, the axles aren't tough enough to handle all the recoil. There is a special screw-jack mechanism by which the gun crew lets the weight down to rest on solid ground.

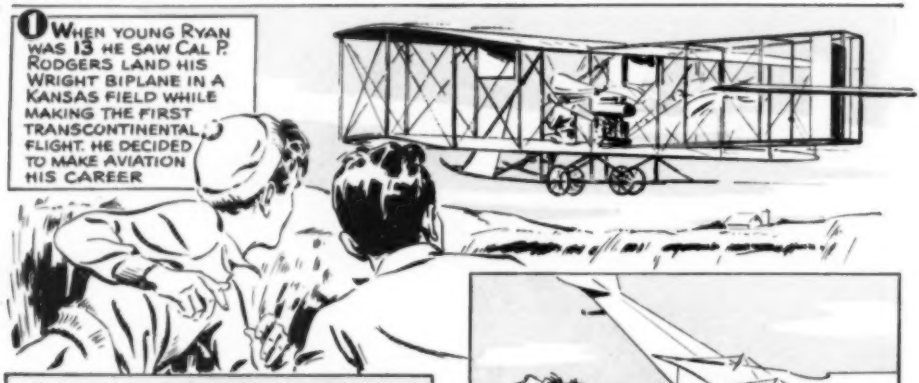
Similarly, the limber—the two-wheeled truck which carries the trails of the gun when they are folded together for transit—has an elevating screw which easily locks them and lifts them off the ground. So mobile are these big weapons that they can speed along a road at 30 miles an hour, towed behind a six-wheel-drive truck. Within less than half an hour they can be unlimbered, their trails spread, their spades dug in, their noses lifted, and start b'lazing away.

The job for which the 155's were designed is a fairly stable battle condition where the object is to neutralize or forbid a vantage point where the enemy might attack. A battery of 155's can make a stretch of woods or a crossroads very uninhabitable.

7 Ready for action, with crew at "cannoneers' posts." Chief of section is seen at left, side to camera. Gun squad consists of gunner (G) and eight men (1 to 8) who serve the piece. Ammunition squad consists of ammunition corporal (A) and four men (9 to 12) who bring up projectiles and charges

Here's My Story

CLAUDE RYAN, BUILDER OF THE SPIRIT OF ST. LOUIS AND OF THE FAMOUS RYAN ST ARMY TRAINING PLANE, WAS BORN IN PARSONS, KANSAS, ON JANUARY 3, 1898



1 WHEN YOUNG RYAN WAS 13 HE SAW CAL P. RODGERS LAND HIS WRIGHT BIPLANE IN A KANSAS FIELD WHILE MAKING THE FIRST TRANSCONTINENTAL FLIGHT. HE DECIDED TO MAKE AVIATION HIS CAREER

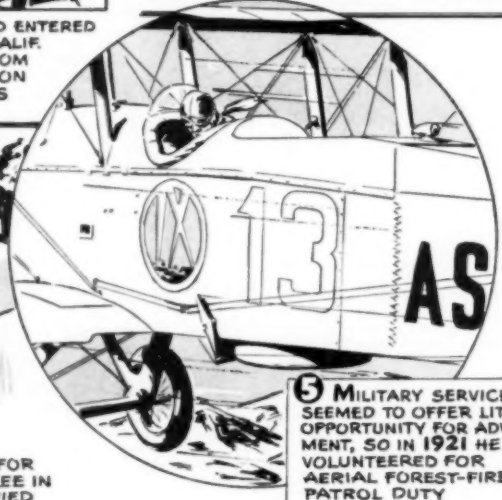
2

BY 1917 HE SAVED $500 AND ENTERED A FLYING SCHOOL IN VENICE, CALIF. PART OF THIS MONEY CAME FROM THE SALE OF A LAUNDRY WAGON WHICH HE USED FOR DELIVERIES IN SUMMER VACATIONS

3

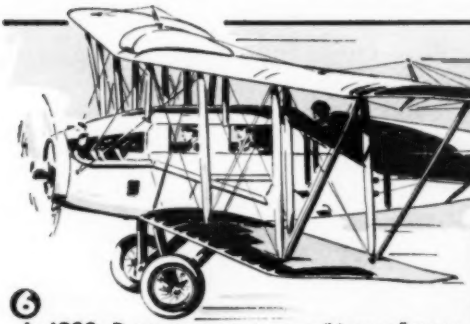
ON RYAN'S SOLO FLIGHT AT THE AVIATION SCHOOL, HE BROKE A PROP WHICH COST $75 TO REPAIR. THE PROPRIETOR COULD NOT PRODUCE THE MONEY AND THE SCHOOL FOLDED FOR LACK OF FLYING EQUIPMENT

4 TWO YEARS LATER RYAN WAS ACCEPTED AS AN ARMY FLYING CADET. IN 1919 HE WAS SENT TO MARCH FIELD, CALIF., FOR TRAINING AND WAS ONE OF THREE IN HIS CLASS OF 75 TO BE CERTIFIED AS A PURSUIT PILOT



5 MILITARY SERVICE SEEMED TO OFFER LITTLE OPPORTUNITY FOR ADVANCEMENT, SO IN 1921 HE VOLUNTEERED FOR AERIAL FOREST-FIRE PATROL DUTY

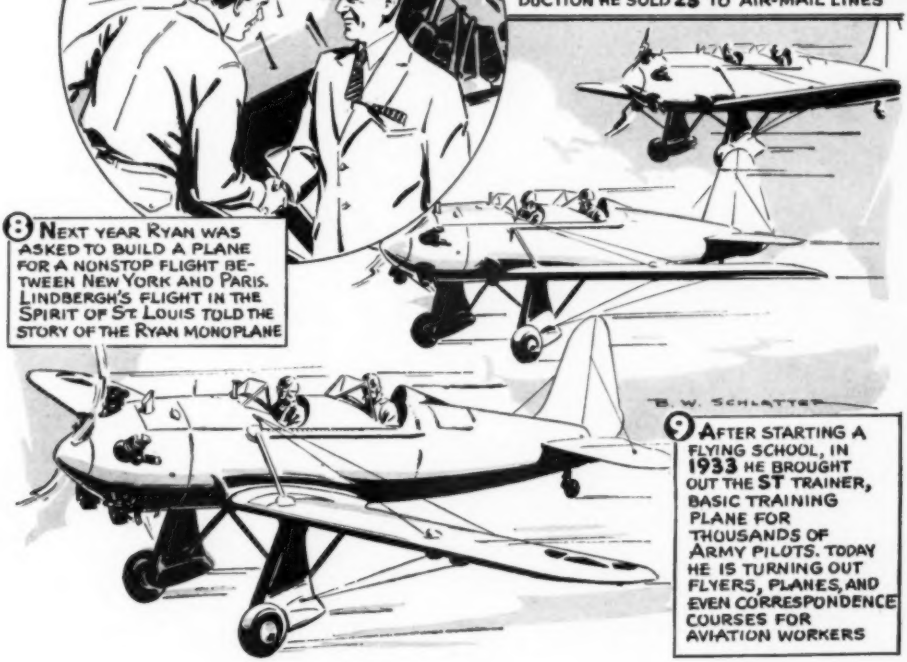
THE CAREER OF CLAUDE RYAN



6 IN 1922, RYAN BOUGHT AN OLD "JENNIE" FROM THE ARMY. THREE YEARS LATER HE CONVERTED SIX STANDARD BIPLANES INTO PASSENGER CRAFT AND OPENED THE FIRST AIR LINE OPERATED ON A REGULAR SCHEDULE, FLYING ONE ROUND TRIP DAILY BETWEEN LOS ANGELES AND SAN DIEGO

7 DURING 1926, HE BROUGHT OUT A HIGH-WING, MAIL-CARRYING MONOPLANE KNOWN AS THE M1, WHICH REPLACED THE OLD DE HAVILLAND IV. IN HIS FIRST YEAR OF PRODUCTION HE SOLD 23 TO AIR-MAIL LINES

8 NEXT YEAR RYAN WAS ASKED TO BUILD A PLANE FOR A NONSTOP FLIGHT BETWEEN NEW YORK AND PARIS. LINDBERGH'S FLIGHT IN THE SPIRIT OF ST. LOUIS TOLD THE STORY OF THE RYAN MONOPLANE



B. W. SCHLATTER

9 AFTER STARTING A FLYING SCHOOL, IN 1933 HE BROUGHT OUT THE ST TRAINER, BASIC TRAINING PLANE FOR THOUSANDS OF ARMY PILOTS. TODAY HE IS TURNING OUT FLYERS, PLANES, AND EVEN CORRESPONDENCE COURSES FOR AVIATION WORKERS

Backing

Army student-mechanics at Chanute Field, where they learn how to maintain and repair bombers and fighters in the battle zone

THESE AIR FORCE SPECIALISTS ARE THE MEN WHO KEEP 'EM FLYING

- Airplane and Engine Mechanics
- Shop-Maintenance Mechanics
- Airplane-Engine Service Mechanics
- Carburetor Specialists
- Electrical Specialists
- Instrument Specialists
- Power-Plant Specialists
- Propeller Specialists
- Battery Repairmen
- Cable and Wire Workers
- Parachute Riggers
- Welders
- Woodworkers
- Dope and Fabric Workers
- Radio Mechanics
- Weather Observers
- Armorers
- Bombsight Repairmen
- Power-Turret and Gunsight Mechanics
- Machinists
- Automobile Mechanics
- Photographic Specialists
- Teletype Repairmen
- Link Trainer Instructors
- Hydraulic Specialists
- Landing-Gear Repairmen

Up the Glory Boys

CALL 'EM "AIR MACS" OR "GREASE MONKEYS," THEY'RE NEEDED BY THE THOUSANDS TO KEEP OUR WARPLANES IN THE FRAY

By CARL DREHER

EVERYBODY knows about the pilots and bombardiers and gunners who shoot down enemy planes and pulverize manufacturing centers and military installations. They are the glory boys, and, from Brigadier General Doolittle down to the greenest flying cadet, they deserve all the medals they can get, and then some. But you can't have an air force without mechanics just as you can't have a theater without stagehands.

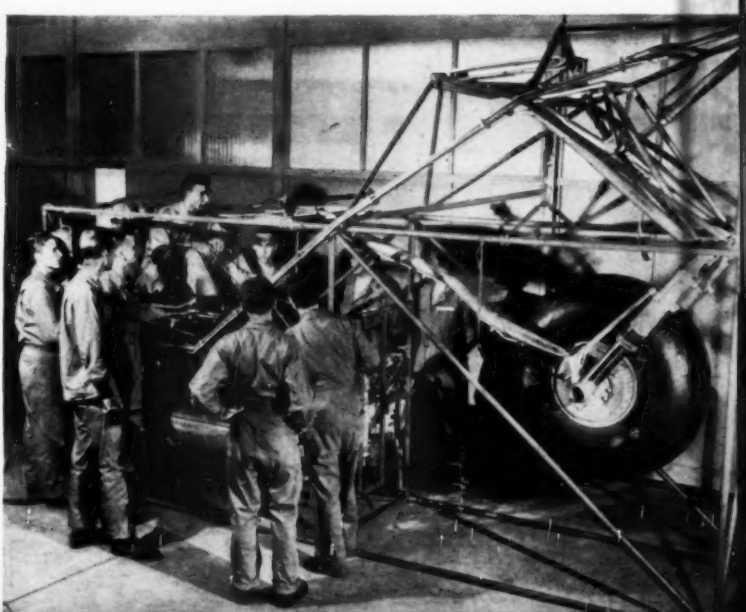
"Keep 'Em Flying" is a fine slogan, but it takes more than words to do it. It takes men in vast numbers. "Grease monkeys," they call them. The term implies no disrespect—quite the contrary. A good airplane mechanic is just about as important as a good pilot, and not much easier to get. "Only a pilot appreciates good maintenance work," someone has said. The reason is obvious—the pilot appreciates his own neck.

Bad airplane maintenance and overhaul can lose a war. And unless it's extremely good, airplane maintenance is bad. For that reason the Army and Navy are willing to invest a few thousand dollars in training anyone who looks promising. What he was before—salesman, farmer, soda jerker—is irrelevant. Required are a show of aptitude, followed by demonstrated ability to learn by doing, and character—the mental and emotional attitude that keeps a man from putting his O.K. on his plane until he knows it is 100-percent airworthy.

Quantity is as important as quality when 185,000 military planes are involved. Mechanics are a real bottleneck in the program. In 1938, at the time of Munich, the Army Air Corps was turning out 1,000 aircraft mechanics a year. The present requirements are more like 1,000 a day. The Army's Technical Training Command, under Major Gen. Walter R. Weaver, is making prodigious efforts to supply them. For a million men in the air—this year's goal—about 750,000 will be needed on the ground, and the majority will be mechanics. For twice a million in the air next year, over a million maintenance men will be needed in the field.

The country needs the men, and the men

All become specialists. Below, at a hydraulic mock-up, a student group gets instruction on retracting landing gear. At left, it takes only one pilot to fly a big Army bomber, but to keep him flying, there must be scores on the ground, working as a team and each an expert at his own job



themselves will benefit after the war. A considerable part of the training may be his bread and butter then. But what he gets out of it will depend largely on himself. To serve his country well and to succeed in the Army, he may have to specialize —learn one part of one tactical plane so well that he knows it in his sleep. Nowadays airplane mechanics can't be all-around handymen. Aircraft are far more complex than automobiles, have hundreds more parts, and work on far closer tolerances than the finest of cars.

At the same time, to succeed later on, the soldier-mechanic must continually broaden his training by reading technical books, manuals, and magazines, and by learning as much as he can from the men with whom he comes in contact whose experience is wider than his own.

If we follow the soldier from his induction to his assignment to a tactical maintenance group, we shall see that it is essentially a process of specialization. He starts as an undifferentiated soldier like any other. If he decides to become a signal man or a clerk in the paymaster's department, or an airplane mechanic, he has already differentiated himself—he is already starting to specialize. His first hurdle is the general classification test that all new soldiers take. Most of the men who receive technical training are picked from those who make above average on this examination. A cardinal mistake, therefore, is to regard the classification test as just another tiresome filling out of forms. Here the soldier must put his best foot forward. It is up to him to show that he has those qualities of reliability, precision, and order which make him promising raw material for one of the most critical jobs in the service.

Emblem of the Air Base Detachment (Washington), a many-armed bee

If he succeeds—and the Army is only too anxious to have him succeed—he goes to one of the four Technical Training replacement centers. Here he gets a general military orientation course, comprising four weeks of ground drill, instruction in the customs of the service, and the like. In the meantime he is again examined for what he can do best—he takes another step toward specialization. The Army is interested in his previous experience. An automobile mechanic who has been working on front-wheel camber, for instance, would be a logical candidate for landing-gear work on airplanes. But aptitude counts for more than experience, for there just aren't enough experienced men to do the job.

Next our potential airplane mechanic—we will call him Jim Jones—is sent to one of the five technical schools of the Army Air Forces, or to one of about 15 civilian schools now operating under War Department contracts. The courses at all are strictly practical. Books and manuals are used, but most of the study is on equipment —mock-ups or operating models of parts of planes, or on the planes themselves. Which school Jim attends will depend on what he is going to do. Perhaps he has been an amateur radio operator or the tests show that he has quick auditory perception and other qualities needed in radio communication. In that case he may go to Scott Field in Illinois, where aeronautical radio operators and mechanics are trained. Chanute Field, also in Illinois, turns out aircraft mechanics, some specializing on engine maintenance and overhaul and others on airframes—aerodynamic structures and controls. But this is only the beginning of specialization. Specifically, a Chanute Field graduate may be a welder, a sheet-metal worker, an electrician, a parachute rigger, a specialist on carburetors and fuel injection devices, propellers, or airplane instruments, or a link trainer operator. If Jim Jones is going to be an armorer, in charge of maintenance on turrets, machine guns, and cannon, a photographer, or a bombsight specialist, he may be sent to Lowry Field in Colorado. Other major training centers are Keesler Field in Mississippi and Sheppard Field in Texas, where the range of courses more or less duplicates that at Chanute.

A post like Chanute is a city in itself, with its own utilities, residences, clubs, roads, traffic control, theaters, churches, athletic fields, and a population of about 20,000. It is a factory city for the mass production of skilled individuals, and it works in three shifts. Here Jim may spend the next 18 weeks, more or less, of his Army career. The actual time depends on the courses he takes. Regular courses vary from 6 2/3 weeks for parachute riggers and teletype maintenance men, to 18 1/3 weeks for plane mechanics. There are also advanced courses for power plant, electrical, instrument, and propeller specialists, and

Specialization takes in a wide range. At left, this class at Chanute is learning how to repair flyers' uniforms, just one of many jobs needed to "keep 'em flying"

a 21 2/3-week course for the weather forecasters.

We cannot follow Jim through all the courses he might take; the syllabus outlines alone cover 70 single-spaced typewritten pages. Just for illustration, let us assume that Jim is allocated to the airplane mechanic's course, the purpose of which is to

Above, repair and maintenance of teletype machines are taught to other students. Many of these specialized courses are given at dozens of other fields

And the Navy also conducts its network of ground schools with technical training at fields and factories over the country. At left, a seaman studies the intricacies of the landing gear

train enlisted men in "the performance of first echelon maintenance of standard airplanes, engines, and airplane equipment." There are four maintenance echelons. The first two are charged with keeping airplanes in service at forward airports; the third and fourth are responsible for complete repair and overhaul at depots some distance back. Jim, then, is to be trained to maintain combat craft under conditions of maximum stress and to work with front-line fighters and bombers.

His training begins with 70 hours of basic instruction. (All figures here are approximate, and, like railroad timetables, subject to change without notice.) He learns the organization, inspection, materials, shop fundamentals, and a certain amount of "trade science," which includes electrical fundamentals like Ohm's law, series and parallel circuits, and electromagnetic induction. From this Jim goes on to another 70 hours of study of airplane structures, from tires to fuselages, nacelles, wings, stabilizers, flight control surfaces, engine mounts, and all the other parts that enable an airplane to fly. He learns the fundamentals of cleaning, lubricating, and ground handling. There is a techinque in climbing around on a plane without damaging it, attaching a towline, and other procedures which are not as obvious as they seem. Another 70 hours apiece follow for hydraulic systems and miscellaneous equipment, propellers, instruments, and electrical systems, and some 210 hours for engines and their functional divisions. The course winds up with 70 hours of inspection and maintenance on single-engine planes, comprising preflight, daily, 25-hour, 50-hour, and longer-interval inspections, and a final 70 hours on multi-engine planes. Total, 770 hours.

Those 770 hours, put in at a commercial school would have cost Jim around a thousand dollars in tuition and living expenses. The Army presents no bill for tuition, defrays all the student's living expenses, and takes care of him if he gets sick or needs a tooth filled. On top of that it pays him $50 a month. It is a lot better than hanging around the drugstore, as many boys like Jim were doing ten years ago through no fault of their own.

But it is not a snap and what Jim gets is not the gift of a generous government. He gives as much in return. When he gets up front he may have to give his life. The bombs are dropping there, and a grease monkey can get killed on the ground just as fast as a pilot in the air. While he is at school, the student mechanic has to work as he never worked before. This is no leisurely college course, but an intensive training regimen where a man is expected to acquire in three months the knowledge and skill which might be expected in six months or a year in normal times. It is one of those "must" situations. If the soldier can't make the grade, he is washed out long before the 770 hours are up, and goes into a branch for which he is better fitted.

If he has average ability and does normally well in his studies, Jim goes from the training field to an Air Forces operating base, either in the United States or abroad. Here he becomes a member of a ground crew of between four and a dozen men, depending on the size of the plane serviced, and further specializes. He concentrates on carburetors, wings, superchargers, or any one of a few dozen other items, and that may be his job for the duration. When you go in for 185,000 airplanes there must be mass production and specialization in maintenance and overhaul just as there is in engineering and manufacture.

But the Army is not only developing specialized mechanics; it also needs supervisors with "technician" ratings, corresponding to foremen in civil life. If Jim looks like supervisory material in his basic training course, the Army will make a further investment in his education. Instead of sending him directly to an operating base, it will give him another month or longer at a factory training school. These schools are operated by airplane manufacturers under Army supervision. Nobody knows the inside of an airplane as well as the men who make it, and the manufacturer of a given type is in the best position to furnish instructors who will impart a maximum of knowledge in a minimum of time.

Thus Jim may go to the Glenn L. Martin school at Baltimore to learn all he can about the B-26 Martin bombers, or to Roosevelt Field on Long Island, which is near the Republic Aviation plant at Farmingdale, to study the P-47 high-altitude fighter, or to any one of a score of similar schools. He learns the technique of trouble-shooting, minor repairs, inspection, and general maintenance on that particular ship under tactical conditions. To get in he has to be a picked man. Washouts at these advanced schools are practically nonexistent. The graduates are in an excellent position for promotion. Many of them become key men and crew chiefs charged with responsibility for maintenance of a fleet of planes of the type studied at the advanced school. Others become specialists in the care of engines, propellers, or radio equipment. Some who develop aptitude for flying become flight engineers or pilots, noncommissioned or commissioned.

The Navy has a similar system operated

under the supervision of the Bureau of Navigation. In peacetime the Navy trained mechanics and other maintenance men under an apprentice system at the Naval Aircraft Factory at Philadelphia and at other naval establishments. During 1941 a vast expansion in aircraft vocational training took place, and there are now Naval Trade Schools at Jacksonville, Fla., Norfolk, Va., San Diego, Calif., at other air stations, civilian universities, and vocational schools, and at manufacturing plants working on production of naval aircraft.

In both the Army and Navy men who rate noncommissioned grades receive pay and allowances which compare favorably with the remuneration of corresponding jobs in civil life. The following table shows the base pay in the United States and abroad:

Grade		Pay per Month	
Army	Navy	U. S.	Abroad
Master sergeant	Chief petty officer	$138	$165.60
Technical sergeant	Petty officer, first class	114	136.80
Staff sergeant	Petty officer, sec'd class	96	115.20
Sergeant	Petty officer, third class	78	93.60
Corporal	Seaman, first class	66	79.20

This represents good pay and the total amount disbursed to enlisted men and noncommissioned officers engaged in aircraft maintenance must be something that not so long ago would almost have paid the whole Army. Yet it is not enough. In July of this year the shortage of aviation maintenance men was about 50,000, and week by week the shortage grows as the goal is raised so that the requirements of the million-man air force may be met.

Soldier-mechanics specializing in the powerful Allison motor learn their job first hand

Propellers are studied by other classes. In this big war it's teamwork by specialists that counts

Mechanics don't always stay on the ground; some, with an aptitude for flying, may end up as pilots

INVENTORS FIND WAYS TO HELP

RUBBERIZED TUBE SUCKING IN AIR OPENS PARACHUTE

Equipped with an inlet tube to admit blasts of air, this parachute opens swiftly when it begins to unfurl. The tube is of rubberized silk or similar fabric and tapers slightly from the intake end which is held open by a rigid ring. Lateral vents near the outlet help to spread air to the sides of the sail to keep it inflated

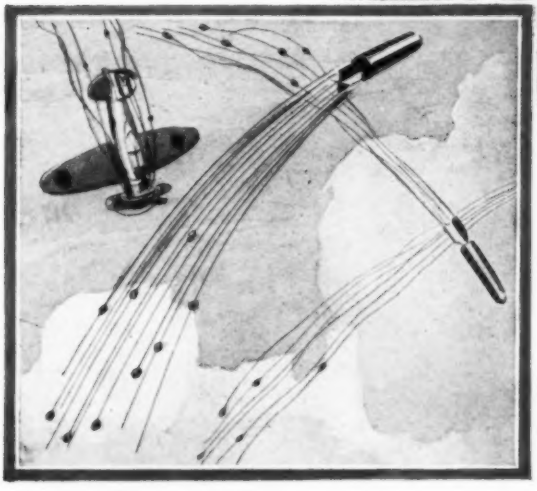
MODERN war being a battle of machines, inventors of the United Nations have gone all out in their efforts to perfect weapons and improvements on weapons that will aid in bringing about a quick defeat of the Axis. On these pages are shown five of the latest—an automatic parachute that is opened by the rush of air, a new sight for the tail guns in big bombers, smoke-producing bullets for riflemen and machine-gunners, floating gasoline "bubbles" to speed the refueling of seaplanes, and wire-dangling rockets that can be shot into the air to ensnare enemy aircraft.

SIGHT FOR TAIL GUNS. To make it easier to aim the tail guns in big bombers, a Los Angeles, Calif., inventor offers a telescopic sight that does not move with the gun but remains stationary in line with the fuselage of the plane. It is a wide-angle fixed telescope fitted with a movable sighting reticule connected to the gun in such a way that its movements correspond to those of the gun to bring the target on the crosslines when the gun is on the target. This allows the gunner to sight without moving from side to side as he swings his gun from side to side

WIN WAR

"BUBBLES" FUEL SEAPLANES
Several seaplanes can be refueled at one time from floating gasoline "bubbles" such as these. They are filled from a tender, lowered into the water, and anchored where the planes can approach and pump fuel into their tanks. Since gasoline is lighter than water, the fabric balloons float when full. Flasks release carbon dioxide as they are emptied to keep them afloat then

RANGE-FINDING WITH BULLETS
is possible for machine-gunners and riflemen who may soon use hollow shells filled with a smoke maker, such as titanium tetrachloride, and thus be able to correct their aim as artillerymen do now. These new shells will withstand the shock of firing, yet be ruptured on impact at any angle. For night use, they are filled with a flashing compound



DEADLY WIRE TENTACLES ON ROCKETS ENSNARE AND CRASH ENEMY BOMBERS

Many new ideas are being developed along the lines of the antiaircraft "spaghetti shell," Britain's rocket that trails long tentacles of wire to entangle the enemy's planes. Several methods other than the use of rockets are proposed for getting the deadly steel tentacles into the air, among them shells, balloons, and planes. One of the latest plans to be brought out calls for stringing the wires at intervals with small bombs that would act as mines either when struck directly by a plane or pulled into contact with it by the winding action of a snarled propeller on the wires

Building Ships

SHIPS BUILT

FOR every ten ships that slide down the ways of American shipyards, the Army's Services of Supply is, in effect, building an eleventh, and perhaps even a twelfth, by revolutionary improvements in methods of packaging war materials. On the basis of what has already been accomplished, Army and civilian experts predict an over-all saving of from 10 to 20 percent in precious cargo space, with corresponding reductions in weight and packaging costs. On many individual items the space saving will range from 60 to 80 percent. An additional saving of approximately 20 percent in critical materials is being made by the use of substitutes and by making what is available go farther.

To overcome problems presented by diverse packaging demands, boxes, crates, and containers are being redesigned, made of different materials, and thoroughly tested at such experimental stations as the Package Research Laboratory at Rockaway, N. J., and the Department of Agriculture's Forest Products Laboratory at Madison, Wis. Packages are carefully inspected to see that every inch of space has been utilized, and are then tested for durability by being put through machines which simulate the jolting and banging of travel.

The packaging experiments cover thousands of items, from canned goods and toothbrushes to tanks and guns, and many articles have been redesigned to permit easier and more efficient packing. For example, ordinary water and garbage cans, formerly shipped singly, are now nested six to a crate, with a space saving of from 70 to 80 percent. At several warehouses, clothing is being compression-baled instead of being packed in boxes, while shoes, once shipped in individual cartons, are being bulk-

NEW PACKING MAKES HALF-TRACKS EASY TO HANDLE

Until recently, 450-pound half-tracks for armored cars were packed flat, as shown below. The new triangular pack at the right saves thirty percent in stowage space

with Packing Cases

SHIPS SAVED
BY COMPACT PACKAGING

packed. Radio tubes are being packed by a new method whereby 180 pieces of packaging material are saved for each 1,000 tubes.

At the Raritan Arsenal, important experimental work is being done under the direction of Lieut. Col. H. H. Knowlton, who was a well-known packaging expert in civil life. Before Colonel Knowlton was assigned to Raritan, 37-mm. guns were packed one to a box. Now they are packed four to a box, the package ready for shipment taking up only 14 cubic feet more space than the old pack of one gun. Colonel Knowlton has also designed a new box to hold a spare-parts truck, which uses 350 feet less lumber than the old crate and weighs 800 pounds less. The packaging of motor vehicles is being further studied at a Motor Vehicle Boxing Clinic which the Army has established at Fairlawn, N. J., in co-operation with the General Motors Overseas Corporation.

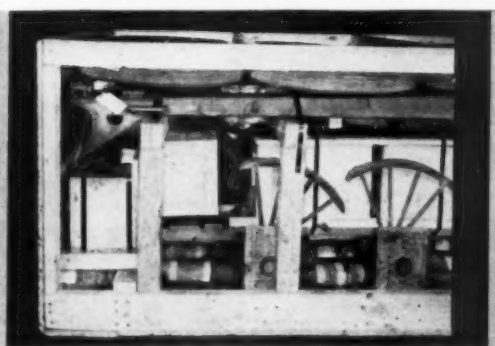
COMPACT PACKAGING SAVES SHIPS

In addition to the cargo vessels that are sliding down the ways of American shipyards in a steady procession, a phantom fleet is helping to supply our troops and allies abroad. It is composed of the cargo space being saved by more efficient methods of packing war materials. Cubic inches of shipping space are as vital today as guns and shells, tanks and planes.

Until recently the hard-rubber half-tracks for Army vehicles, weighing about 450 pounds, have been packed flat. In this form they proved difficult to handle and took up a great deal of space. The Firestone Company has devised a triangular pack, made by bending the track about wooden disks, which has saved some 30 percent in shipping and warehouse space.

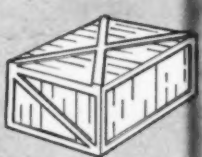
(CONTINUED)

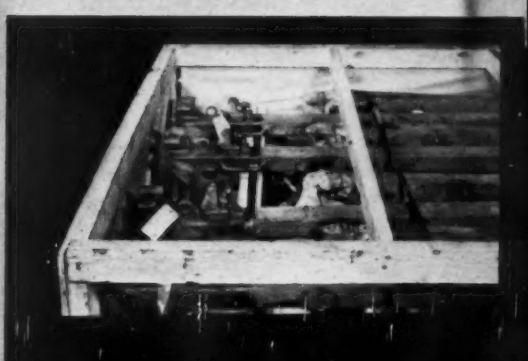
PUTTING FOUR 37-MM. GUNS IN THE SPACE OF ONE



THEN

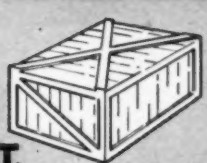
1 GUN
186 CU. FT.





NOW

4 GUNS
200 CU. FT.



◂THEN

Clothing for the A. E. F. of 1918 often was bundled in the easygoing manner seen in this U. S. Army photo from the Philadelphia Quartermaster Depot. The main compression employed was that supplied by the warehouseman's knee. As a result, ships supplying our troops abroad carried generous cargoes of American air in the space that was wasted

COMPRESSION-BALING FOR ARMY CLOTHING *NOW*

Combat trousers being squeezed in a press for compact baling. Strips of cardboard along edges prevent damage to clothing by steel binding straps

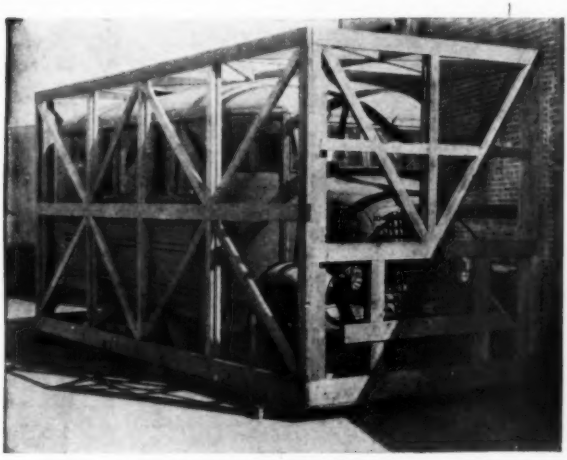
Three wrappings cover each bale: water-repellent paper, crinkly kraft paper (here being folded over an end), and osnaburg, a coarse cloth like burlap

Handles are provided by gathering the osnaburg into "ears." There are four of these on each bale. About five inches of cloth is used to form an ear

Crimping the binding straps after they have been tightened with a special tool. Combat trousers are packed 30 to a bale, other items in other amounts

NOW

JEEP IN A BOX. On an assembly line, boxes are built around knocked-down quarter-ton cars for foreign shipment. Each case contains a complete car with its tires and all other equipment



A spare-parts truck in a box designed by Col. H. H. Knowlton at the Raritan Arsenal in New Jersey

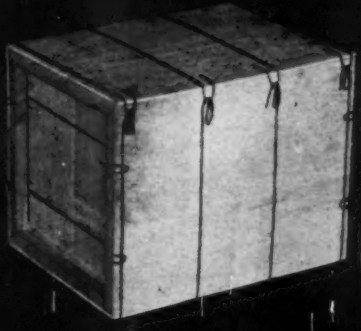
How rear wheels are blocked. This box weighs 800 pounds less than one formerly used for the same job

THEN

Barrels were used for small parts in World War I. Round, they wasted cargo-ship space

NOW

Square boxes, made of light wood, stack easier and can be packed close together



It's manganese steel in the new U. S. Army helmet that gives our soldiers the ultimate in protection

Steel's

Manganese Puts the Hardness into the Weapons of War and the Tools of Production. We Need Lots of It. New Sources Promise an Adequate Supply

WHEN an American soldier goes into battle, the best helmet ever produced by military science guards his life. One by one, experts have passed judgment upon every imaginable steel alloy for its outer shell—and have decided upon manganese steel, the toughest known.

That is only one of a great number of reasons for rating manganese as Strategic Metal No. 1 on the country's shopping list. Consider some of the things that take the greatest shocks and resist the greatest wear—the qualities that, together, make up toughness—and there you will find manganese steel. In frogs and switch points of railways, it stands up under the thundering impact of fast, heavy-laden trains, rushing troops and materials of war to their destinations. Clashing and scraping dippers of power shovels, working open-pit mines and quarries, demand manganese steel. You will find it in heavy-duty chains, gears, crushers, wheels, and bearings. Its curious property of being nonmagnetic leads to its use in cover plates for powerful lifting electromagnets; when the operator

Crown jewels of steel's kingdom are small heats of special high-manganese steel like this one being tapped from an electric furnace. Below, a sample of ferro-manganese, often used to add manganese to steel

Tough Partner

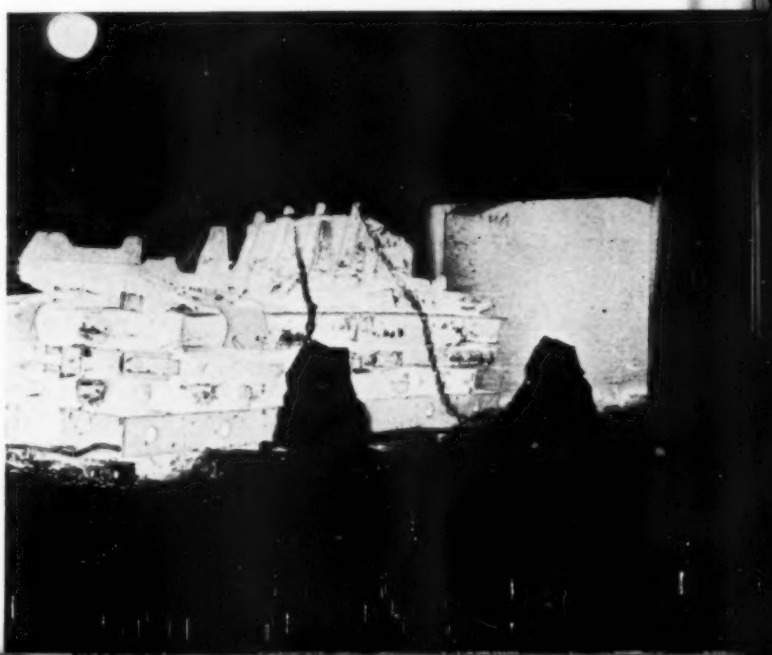
shuts off power, the load drops cleanly, leaving no stray particles adhering to the iron poles from their residual magnetism.

Crown jewels of the Kingdom of Steel, relatively small heats of the near-precious alloy—containing from 10 to 16 percent of manganese—are practically custom-made in electric furnaces at 3,000 degrees F. Then the heat is tapped into a crucible and poured into molds, forming castings that may range in size from a half-pound chain link to a 25,000-pound shell for a dredge pump. Stacked on a furnace car, the castings get a 1,850-degree heat treatment in another furnace, and then are plunged into a large tankful of cold water. They emerge too tough to be machined by ordinary tools, and are finished by special grinders. Dramatic steps in the process may be seen in a pair of striking photographs reproduced below, through the courtesy of the American Manganese Steel Division of the American Brake Shoe & Foundry Company, which specializes in producing this particular type of alloy steel. Other manganese steels contain from about 1½ percent of manganese upward, to suit a variety of purposes.

By far the bulk of manganese that goes into steel, however, does so in traces amounting to only a small fraction of one percent. Nearly every kind of steel needs about 12½ pounds of manganese to the ton, to remove unwanted sulphur and oxygen. The sulphur, particularly objectionable, makes iron brittle when hot—or "red-short" in steelmakers' language. By imparting ductility, manganese permits forging and rolling without damage. Substitutes such as zirconium and titanium have been proposed, but they are more expensive and even harder to get. So manganese remains an indispensable ingredient of good steel.

With other metals, too, manganese forms useful alloys. Propellers of naval vessels and cargo ships are made almost exclusively of manganese bronze. For hardening aluminum, manganese provides one of the few metals that can be used without diminishing resistance to corrosion. Manganin—an alloy of copper, manganese, and nickel—responds so slightly to temperature changes that research workers use it to make standards of electrical resistance.

Chemical compounds of manganese run the gamut of rainbow hues—rose red, violet, emerald green, reddish purple—but the most useful of all, from a layman's point of view, is the coal-black powder called manganese



Glowing-hot castings, stacked on a furnace car, are tended by modern alchemists in strange hooded garb. After heat treatment in this furnace, the castings are plunged into water. These steps remove brittleness and toughen the product for the jobs that lie ahead of it

dioxide. Made into a paste with current-conducting graphite and sal ammoniac, manganese dioxide forms part of the unseen filling of a dry cell, such as you use in a flashlight or for ringing a doorbell. In a cell of this kind, hydrogen forming upon the central rod of carbon tends to insulate or "polarize" it, interfering with internal flow of current from the zinc shell. By oxidizing the hydrogen to water as it forms, manganese dioxide keeps the cell useful.

Those are reasons why we need manganese. Most of our

Searching for strategic metals, a U. S. Geological Survey prospector comes upon an outcrop of highly valuable manganese ore, in the State of Washington

A specimen of manganese-bearing shale from South Dakota, where new recovery methods are awaited

Below, pure manganese is being made in a new pilot plant located in the West. The metal, rarely seen in its pure state, is deposited upon steel plates (at left) in the bank of electric cells in center

prewar ore came from Russia, India, Africa, and Brazil. Now these imports are restricted by shipping hazards. However, blue sky can be seen ahead.

Foreseeing a war shortage, Government agencies have laid in huge reserves of high-grade manganese ore, containing at least 35 percent of metallic manganese, which should last several years. Meanwhile, prospectors have been scouring the country for manganese deposits. Bureau of Mines experts have developed ways to turn our abundant low-grade ore into high-grade concentrates, which will serve as well as the imported stuff. Their pilot plants are perfecting these processes for large-scale production, expected to reach a peak in 1944 or 1945, with an annual output equivalent to 600,000 tons of high-grade ore from overseas.

Rose-colored rhodochrosite, whose beauty contrasts with the somber brown or black of other manganese ores, comes from one of the country's few high-grade sources—the Emma Mine of the Anaconda Copper Mining Company, in Butte, Mont. This odd mine opens in the middle of the city's business district, and ore trucks mingle with street traffic.

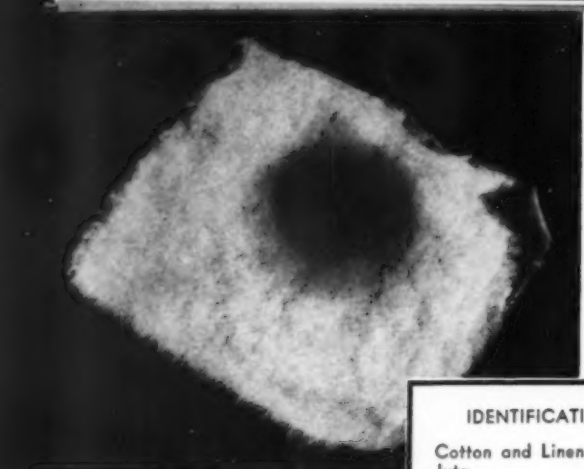
Another curiosity of manganese mining, a machine that explodes ore-bearing minerals like popcorn, has been shipped to Chamberlain, S. D. Vast deposits of low-grade manganese, enough to supply the nation for generations to come, occur as nodules in the shale that borders the Missouri River in this vicinity. Declared capable of handling 1,000 tons of the ore daily, the new device is designed to subject a mass of shale to steam under high pressure. Suddenly the pressure is released. The shale breaks away from the harder manganese nodules, which are easily separated for further treatment.

Most promising of ore-refining methods developed by the Bureau of Mines, an electrolytic process transforms such low-grade ores into metallic manganese, of better than 99.9-percent purity! For the benefit of those who have never seen the metal—and few have—its color is pinkish gray. Its weight about equals that of iron. Deposited from a liquid bath upon plates of stainless steel, it then is stripped off by flexing the plates, and the pieces are broken up and barreled for shipment.

Manganese usually is added to steel in the form of an alloy with iron, called ferromanganese and containing about 80 percent of the strategic metal. This artificial product, made in electric furnaces and small blast furnaces, requires natural ore or concentrates containing 35 to 40 percent of metallic manganese. Now that pure manganese metal from low-grade ore has become available, it can be added directly to steel, replacing ferromanganese manufactured from high-grade ore. The experiment has been made with complete success by the Jones and Laughlin Steel Corporation, vindicating the hopes of research workers and promising a radical way of steelmaking.

Uses for Manganese: from Flashlight Cells to Steam Shovels

MANGANESE makes your flashlight cells last longer, and puts the bite in mammoth shovel buckets. In dry cells, manganese dioxide forms part of the black, pasty filling between the carbon rod and the shell of zinc, as indicated by the pencil in the cut-away cell pictured above. Designed to withstand punishing wear and tear against heavy rocks, the gigantic manganese-steel bucket at the right strips coal from an open-pit mine in Illinois. Men sitting in the bucket give an indication of its size



Simple Kit Identifies Fibers in Textiles

WITH one drop of a newly developed indicator solution, manufacturers, dealers, and consumers can identify any of a dozen popular textile fibers. Replacing a whole series of tests previously necessary, this indicator produces characteristic colors on textiles of different chemical composition. The chemical is deep purple, but makes a light blue spot, for instance, on cotton or linen.

On undyed material, the indicator is applied directly and allowed to remain for two minutes. Then the material is washed in cool water. To identify the textile, the remaining color is compared with a reference table on the bottle. Dyed materials are first stripped of their color by boiling for thirty minutes in a solution of a special compound.

One drop of this chemical will identify the threads from which a cloth sample is woven, turning each of a dozen different fibers to a characteristic color

Tests for fiber content are equally effective on textiles that are spun from vegetable, animal, or synthetic threads, as the table at right shows

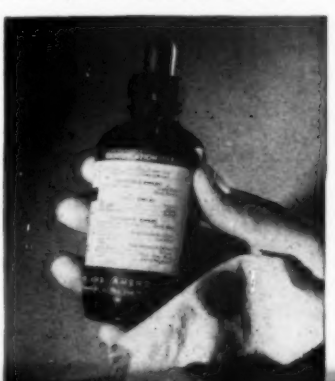
IDENTIFICATION TABLE

Cotton and Linen	Light Blue
Jute	Dark Brown
Wool	Yellow
Silk (Raw)	Black
Silk (Degummed)	Brown
Cuprammonium Rayon	Dark Blue
Acetate Rayon and Nylon	Pale Greenish Yellow
Viscose Rayon	Lavender
Aralac Protein Fiber	Deep Greenish Yellow
Lanital Protein Fiber	Yellow
Polyvinyl Alcohol	Very Deep Blue
Vinyon	Lavender-Gray

THIS POCKET-SIZE KIT containing two chemicals is all that is needed for quick identification of textiles. One is a compound for stripping dyed materials of their color. This is done by boiling a sample for half an hour in a solution. Next a drop from the other bottle is put on the bleached cloth

After the indicator has soaked into the fabric for about two minutes, the spot is washed out in cold water as shown at the left

Then the remaining color is compared with the chart on the bottle for identification. Undyed fibers need no stripping before the test



An army on roller skates: an inventor's scheme for moving troops

Troops May Move on Roller Skates to Save Gasoline and Tire Rubber

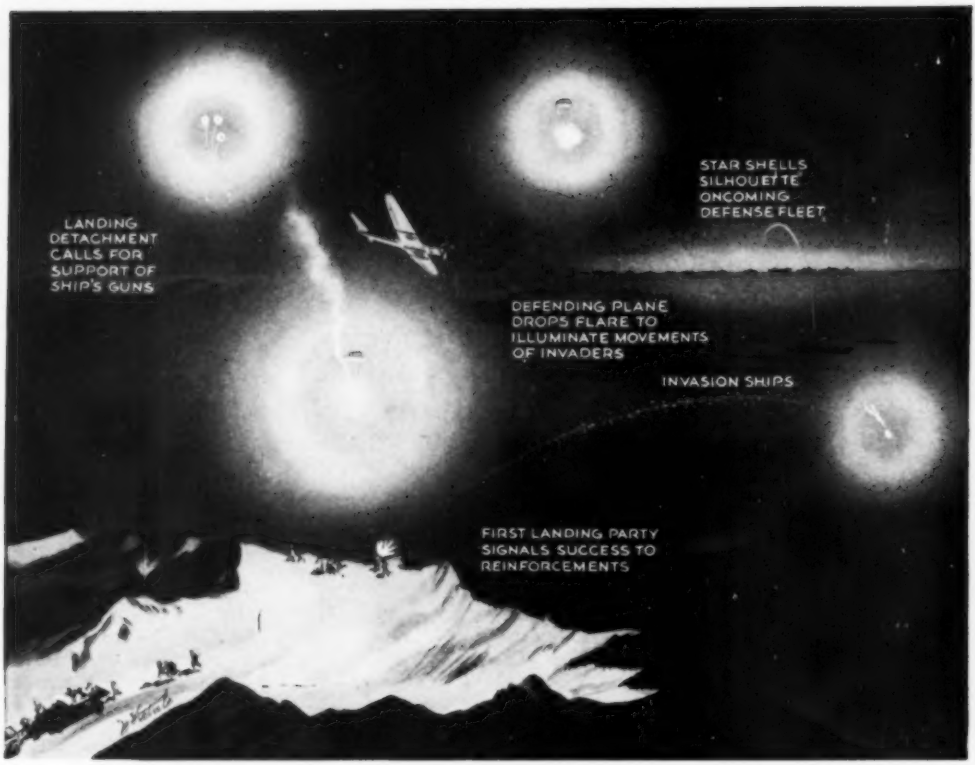
UNCLE SAM'S infantry may soon march to the tune of the "Skater's Waltz." In these days of rubber and gasoline shortages, the Government is considering plans to move its new Army on roller skates.

For this purpose, a pair of lightweight skates, sporting wheels which could be manufactured from any available fabric, is now undergoing road tests. The body of the skate is cast from an aluminum-base alloy in one piece to keep the number of riveted parts at a minimum. Another feature is a new type of bolt which secures the skate trucks to the chassis in such a way that the chances for mechanical breakdowns are very slim. The sensitive wheels are designed to roll gently over small road obstacles, and to swing right or left as the weight of the skater shifts from one foot to the other. The diameter of the wheels, greater than on conventional skates, makes for easier rolling over a rough surface.

In addition to the Army, various civilian-defense organizations are considering using these skates as a sure means of getting past bombed streets swiftly and safely. A group of defense workers, in New York City, even contemplate skating to work to save precious automobile materials.

Wheels swing to right or left as weight shifts between the feet

Specially designed for military use, skates have sturdy one-piece bodies cast from aluminum-base alloy. Wheels are built of fabric


LANDING DETACHMENT CALLS FOR SUPPORT OF SHIP'S GUNS
STAR SHELLS SILHOUETTE ONCOMING DEFENSE FLEET
DEFENDING PLANE DROPS FLARE TO ILLUMINATE MOVEMENTS OF INVADERS
INVASION SHIPS
FIRST LANDING PARTY SIGNALS SUCCESS TO REINFORCEMENTS

Fireworks

NIGHT skies in America, last Fourth of July, probably set a new record for dimness on the national holiday. But on far-away battlefronts, clusters of many-colored stars soared through the air. Very pistols spewed red, white, and green fireballs. Airplanes dropped flares that lit up the country for miles around. Tracer bullets made geometric patterns of flaming lines. Such are the fireworks of war, to which the production of leading American makers has been diverted.

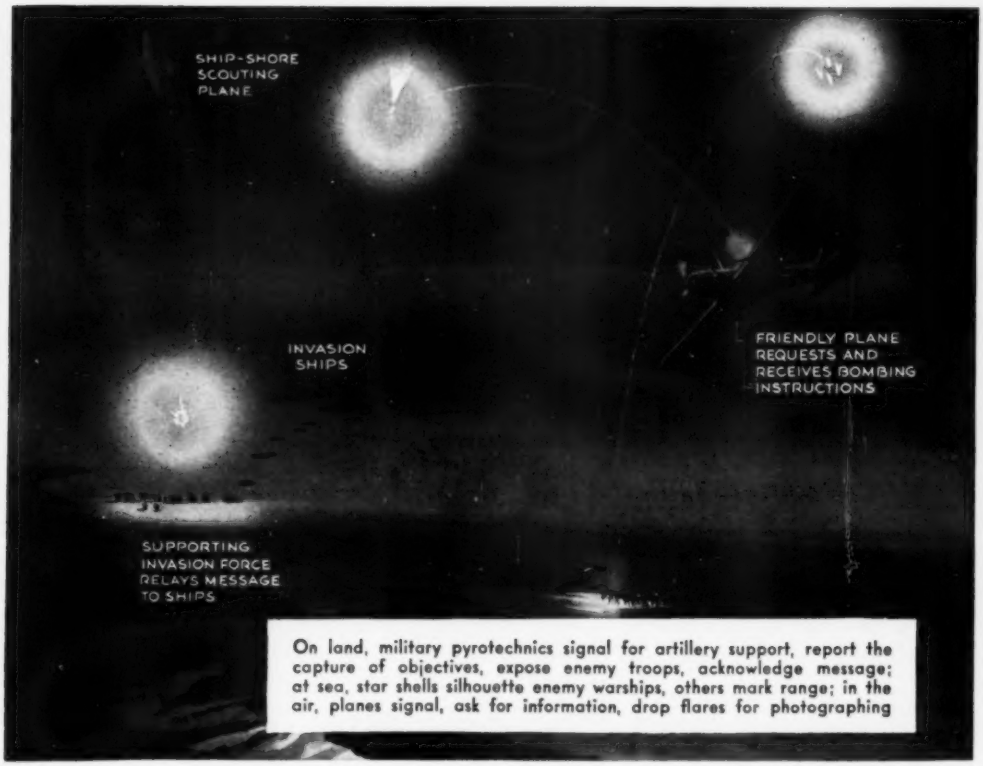
Signaling and illumination both call for pyrotechnics, adding fitful touches of beauty to the grim business of battle. Compared with such methods of communication as wire lines, fireworks throw secrecy to the winds. But they have proved so portable and useful in certain tactical situations that they are now supplied to infantry, motorized, cavalry, and armored divisions, as well as to air and sea forces.

"Aerial countersigns" are reported to have been introduced by British bombers in

Very signal light used by planes or forces on ground

Ground projector light with parachute, used in signaling

Star shells silhouette enemy ships to make better targets


SHIP-SHORE SCOUTING PLANE
INVASION SHIPS
FRIENDLY PLANE REQUESTS AND RECEIVES BOMBING INSTRUCTIONS
SUPPORTING INVASION FORCE RELAYS MESSAGE TO SHIPS

On land, military pyrotechnics signal for artillery support, report the capture of objectives, expose enemy troops, acknowledge message; at sea, star shells silhouette enemy warships, others mark range; in the air, planes signal, ask for information, drop flares for photographing

In War

By ALDEN P. ARMAGNAC

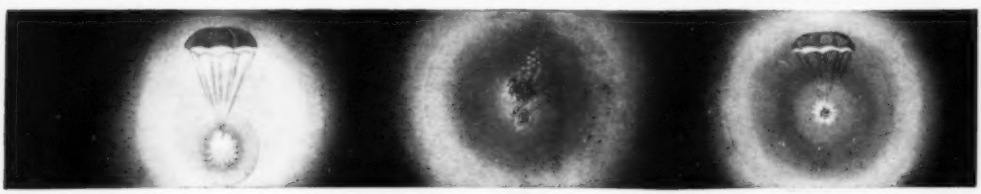
their waves of cross-Channel sweeps. Somewhere in the darkness, an outgoing plane meets an incoming one. Whipping out his Very pistol, one of the outgoing crew discharges a single green fireball. Either the other plane answers with a red one—the prearranged code for the day—or the shooting starts.

In communication between land forces, or ground and air, pyrotechnics serve a variety of tactical purposes. On the march, they keep "foot" infantry, motorized troops, and armored divisions in constant touch with supporting aviation. After deployment from the march, in preparation for attack, radio silence may be imposed. Signal lamps resembling auto headlights, operated by key and pointed at receiving stations through wooden tubes six to nine feet long, transmit messages from advanced positions to the rear by International Morse code. Pyrotechnic signals in the rear acknowledge the messages, since forward-going lamp signals would be likely to betray

Signal light with parachute, the type dropped by plane

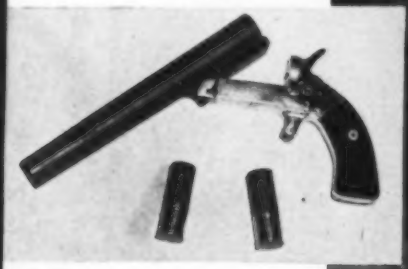
Star-cluster signal of kind shot from ground projectors

White parachute flare for illumination fired from ground or dropped by plane



FIRING VERY PISTOL

In the photo at right, the signalman stands ready to fire when his observer reports. The Very pistol below is broken for loading with the cartridges shown



RAISED SYMBOLS CAN BE READ IN DARK BY TOUCH

Raised markings on the base of Very cartridges make it easy to identify them by feel in the dark. The pistols slip into holsters for carrying, as shown in the photo at the left. The pistol in the next picture is broken and being loaded

the location of the message center and lead to its destruction.

Once the battle is joined all restrictions go by the board. Varicolored lights and flares call for artillery support against a position of unexpected strength. They announce when an objective has been taken. In defense, pyrotechnics are particularly suitable for transmitting prearranged messages. Like other secret documents, pyrotechnic codes are destroyed if capture appears probable, and are changed frequently.

A modern code shows how readily meanings can be varied to suit existing conditions:

"Artillery is firing short." Red Very light.

"Lift barrage." Green Very light.

"Fire barrage." Ground signal, red star cluster.

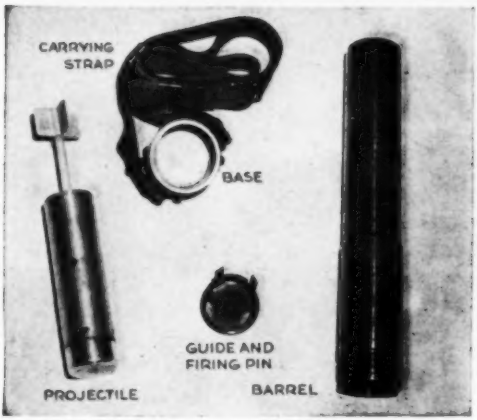
"Objective taken." Ground signal, red chain with parachute.

"Display panels." (Strips of cloth laid on ground to form code symbols.) Airplane signal, white star parachute.

"Understood." White Very light; ground or air signal, white star parachute.

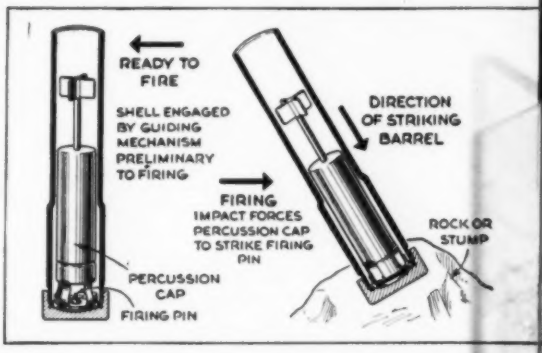
For illumination, pyrotechnics prove indispensable. If an officer hears suspicious noises, such as infiltrating enemy troops might make, he is likely to send up a white parachute flare. In case enemy troops hear the characteristic sound of his ground signal projector resembling the cracks of a light mortar, they fall to the ground. But if caught unawares, they "freeze" into a

GROUND SIGNAL PROJECTOR IS HAND MORTAR



Projector shell and parts of a projector. Fins on the projectile steady its flight in the air. The barrel is slipped over the guide and screwed to the base on which a carrying strap is fastened

Above, to set off the projector, the firing pin at the center of the guide in the base must make contact with the percussion cap on the projectile



Shells are inserted at the mouth of the projector as shown below at left. A sharp impact is needed at the base for firing (right, below), and most often loaded equipment can be dropped without any danger. In firing, impact is usually obtained by striking the projector base on a stone or log. Note that the projector points a little forward. Details of the mechanism are shown in the diagram

tableau—even in the middle of a step—for the minute or two before the illumination dies away. Even a trained observer finds it difficult to distinguish between motionless men and surrounding trees, stumps, and rocks.

For emergency landings, and for aerial observation, airplanes drop larger parachute flares. Their biggest ones serve for night photography. A photo cell in the plane synchronizes the exposure with the flare by tripping the camera shutter at the moment of maximum brightness.

At sea, star shells, filled with a pyrotechnic composition, brilliantly silhouette any enemy warship behind which they explode. Other shells may employ metallic phosphide chemicals, which react with water to form phosphine gas. Rising to the surface, the gas burns spontaneously, serving as a marker to correct gun range. Air arms use a strontium flare that floats to reveal the movements of an enemy naval force. Submarines are equipped to release red flares while submerged.

Daylight fireworks have also been used. Signal grenades and rockets release colored smoke instead of lights. It has been proposed to mix colored smokes, like paints on a palette, to camouflage air targets and blend them with the terrain.

1 BOMB-SHAPED FLARE IS DROPPED FROM PLANE
2 PARACHUTE OPENS AUTOMATICALLY
3 BURNING MAGNESIUM FLOODLIGHTS GROUND
4 PHOTO CELL RESPONDS TO LIGHT AND TRIPS CAMERA SHUTTER
5 CAMERA PHOTOGRAPHS GROUND TROOPS AND INSTALLATIONS AT MAXIMUM BRILLIANCE OF FLARE
ENEMY INSTALLATIONS

A photo cell trips an airplane camera's shutter just as a flare illuminates enemy positions on the ground revealingly in this modern scheme for observing and recording hostilities at night

Nearly everyone knows what a Very pistol is, but few have seen one in use. The single-shot, 10-gauge gun has a nine-inch steel barrel, hinged by a pin to a bronze frame. For loading or extracting a cartridge, the gun breaks at the pin. A standard trigger fires the cartridge, which resembles a shotgun shell. To aid in selecting the right color in the dark, the recessed base of the cartridge bears a raised symbol—a dot for white, a bar for red—that can be identified by touch.

A ground signal projector, like the one illustrated in use by members of the 45th Division, U. S. Army, resembles a short length of pipe, capped at one end. Within, clips permit the rocket-shaped pyrotechnic shell to be dropped safely into the barrel. When ready, the signalman grasps the loaded projector with both hands, raises it, and brings it down smartly upon a rock or stump. The impact allows the projectile, which contains its own propelling charge, to strike a firing pin centered in the base cap. There is a loud report, and the shell is on its way. At night it cannot be seen until it bursts with a shower of stars or with the release of a brilliant parachute flare.

Another type employs a three-foot steel tube, with a flange and sharp pin to be driven into the ground. A quick pull on a lanyard operates a springless hammer, which discharges the cartridge by impact upon a percussion cap. This projector may also be mounted on the muzzle of a rifle.

Ground projectors fire white or colored stars, with or without parachutes.

A "pyrotechnic pistol," which may replace the Very in airplanes, has been introduced. It fires red and white signals equipped with parachutes, and also parachute flares. This gun is simply a heavy frame for holding the cartridge, which serves as the barrel, and measures about 1½ inches in diameter. Because of its strong recoil, it should be held with both hands.

SWEEPINGS MADE TO PAY

FOUR tons of undamaged rivets, bolts, nuts, and other production-line items are recovered weekly from sweepings at the Downey, Calif., plant of Vultee Aircraft, Inc., through the use of an ingenious magnetic separator developed by the company's engineers.

These parts, along with refuse dropped on the assembly line, are dumped at intervals into a hopper at the end of a trommel which screens them according to size. The articles are conveyed on a belt under suction intakes for removal of dust and through a magnetic field which automatically separates steel parts from others.

Bins into which the odds and ends drop at the end of their journey are classified and sent to sorting tables where usable items are picked out and marked for return to the production line.

1 From floor sweepings dumped into a hopper, this trommel screens items according to size. The large pieces of refuse come out at the end

2 Bolts, rivets, and nuts are removed at one point, going onto a conveyor belt which passes through a magnetic field for segregating steel

3 Parts thus separated are sorted further by hand and inspected for damage. All usable items are then sent back to the production line

Three simple flats and a door form this set, before which Rosina Galli and Broderick Crawford are acting

Building Home-Movie Sets

By JACK OTTERSON

Supervising Art Director, Universal Studios

YOU may never attempt a defense film, which is proving an increasingly popular pastime these days, but every amateur wishes occasionally for a set against which to arrange his people and props. Either the walls in the living room are too dark, the bedroom is crowded, or some other difficulty interferes with easy shooting.

The remedy is simple. Use flats, the kind we employ in Hollywood. They are light, inexpensive, and easily constructed and decorated. You can put together one or a half dozen in 4′ widths. You can insert a window or door wherever you wish. With the flats you may easily create a room corner, three walls, or one wall and a hallway or room beyond.

Begin with a sheet of plywood—$\frac{3}{8}$″ thick three-ply will be heavy enough. Often the most convenient size to use is a piece 4′ wide by whatever height wanted. Usually 10′ will be adequate. On one side attach a rectangular frame of $1\frac{1}{4}$″ by $1\frac{5}{8}$″ stock reinforced with horizontal crosspieces at 2′ intervals and, if more than 4′ wide, with one or more vertical strips. An example is given in an accompanying drawing which shows the reinforcing necessary for a 6′ by 8′ flat. The rabbeted corner construction shown in the same drawing is sturdy. When more than one flat is required, join them edge to edge, cover the cracks with narrow strips of paper tape, and the main construction job is done.

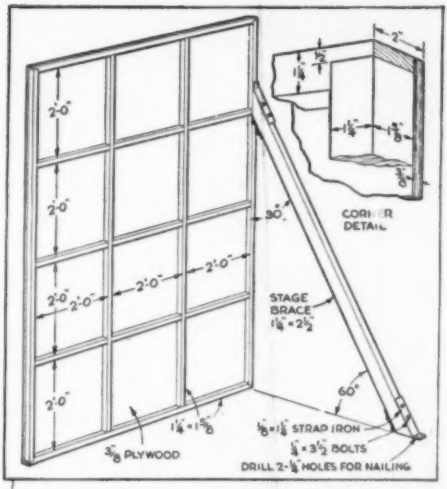
Because flats will not stand alone, even when joined in an L-shaped set, they should be braced against the floor. This is best done with a 6′ length of $1\frac{1}{4}$″ by $2\frac{1}{2}$″ stock, sawed at the top end to form a 30-deg. angle with the frame, and at the other to form a 60-deg. angle with the floor. Fit the top and bottom of both ends with 6″ strips of strap

iron, bent to the required angle and drilled with holes through which nails may be driven into both the floor and flat. It is a good idea to use double-headed nails everywhere except on the main construction. These nails are driven in to the first head, and the second is left projecting for easy removal when the set is not wanted. If sets are used on floors which you prefer not to mar, nail the floor end of the brace to a flat piece of plywood large enough to be weighted down with something heavy.

Now—about the decoration and the installation of doors and windows. For a neutral background, simply shellac the front surface. To get a plain surface of any desired color, apply two coats of paint. If wallpaper is needed, make sure it is applied smoothly, leaving no wrinkles. To remove the paper, moisten the surface with warm water and scrape with a putty knife. Special papers provide interesting textures. Many "marble" walls seen in professional moving pictures are nothing more than flats covered by marbleized paper.

Should you plan to use your set repeatedly, it will be a good idea to set a door and a window into a permanent flat. Simply fill the frame above the door and above and below the window with sections built like the larger flats. Doors and windows can be bought cheaply from a building wrecker.

You will be surprised at the professional effect you can get with these simple sets.



The use of plywood and strong bracing insure the strength and rigidity of the flats needed for a set

Perhaps nine flats would be needed to achieve necessary depth in a three-wall room, while four to five will provide an L section adequate for corner shots. If you set up the three-wall room, run a brace across the open end outside the camera angle. Should the action call for some one to enter the door, place a "wild wall" of two

Jack Otterson, the author, inspects the bracing on the rear of a wall made of two flats and a door

When two or more flats are needed for a set, they are joined end to end and the cracks between them sealed with narrow, adhesive strips of paper tape

Double-headed nails, driven in to the first head, can be pulled out quickly again when shooting is over and flats are to be moved

flats beyond the door, creating the illusion of a hallway. Use a wild wall of two or more flats separate from the main unit when shooting toward the open end of the three-wall room.

As for lighting, either drill holes at 2′ intervals into the upper frame and fit in lamp bases, or clamp flood lamps on the frame and at other desirable points. Back lighting, needed especially for close-ups, may be provided by suspending a lamp from a pole projecting over the flat. Don't be afraid to make use of shadows. If your character enters from a bare hall, cast the shadow of a chair or a potted plant along the wall. This relieves the monotony of the expanse and adds greatly to its photographic value.

The use of flats, once they are assembled, will simplify many of your indoor problems. Most scenes may be filmed with no more than three sections, arranged either as a single wall or a short-legged L that suggests a corner. Sketch the set to visualize the scenes as you prepare the scenario, thus avoiding unnecessary construction.

Diffusing-Cloth Support That Folds Completely Made from Soft-Metal Calendar Binding

DIFFUSING cloths for photoflood lamps are often mounted in homemade holders consisting of embroidery hoops and similar devices. They will take less space to pack away in the photographer's kit, however, if the frame is omitted and they are supported by nothing more than the metal binding strip from an outdated wall calendar. To replace the calendar pages with a sheet of diffusing cloth, simply unfold the soft metal with the aid of a knife blade and pliers, insert one edge of the cloth, and hammer the binding flat. A spring paper clip, spring wooden clothespin, or an attachment made of wire can be added to the center of the arm to enable the cloth to be suspended in front of the reflector at a suitable distance to prevent it from being scorched.—JOHN MODROCH.

An illusion of a hallway or another room can be created by placing a flat beyond a door. These "wild walls," as they are called, are needed when action requires an entrance or exit through an open door. Interesting effects are obtained by casting the shadow of furniture or a plant on this kind of wall

Decorating is as little trouble as building flats. To provide a neutral background, shellac the plywood; for a plain surface of any color, two coats of paint will be sufficient. In general, the lighter shades should be chosen to enhance reflection from your flood lamps

Wallpaper, when used, must be applied evenly. Moisten with warm water and scrape to remove it for redecorating. Special papers are made with interesting textures, such as the rich "marble-wall" effect seen in Hollywood movies

As a case, the box holds camera, accessories, and films. It also acts as table tripod and tilt top. A notched stick provides for the angular adjustment

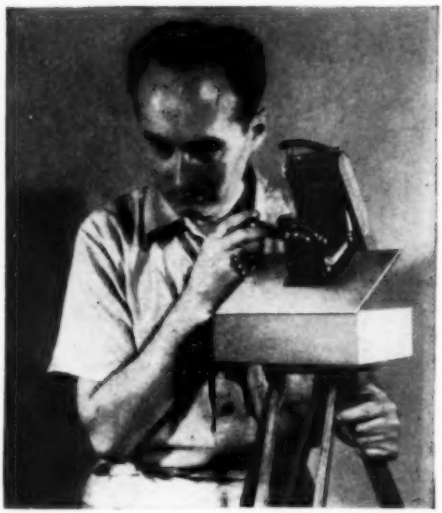
Cigar-Box Table Tripod Holds Camera and Accessories

THIS combination table tripod and camera case has proved very practical for use with a light folding camera. It provides an adjustable tilting top, which can also be used on an ordinary tripod. For table-top use it can be raised by placing one or more books under it. It has ample space for the camera, about six rolls of film, auxiliary lenses, a self-timer, cable release, and other small accessories.

An ordinary wooden cigar box of suitable size is the chief thing required. The hinge may be reinforced with a strip of wide adhesive tape. A slot is cut in one edge of the lid, as shown in an accompanying photograph, to accommodate a notched strip of wood, which is riveted inside the corresponding end of the box and serves to hold the lid at any desired angle. Drill a hole in the lid for a ¼" bolt and wing nut. The nut is screwed part way down on the bolt underneath the lid, to which it secures the camera.

If the camera is very heavy, it may be necessary to add another notched supporting strip at the opposite end of the box. The strip drops inside the box when the lid is to be closed. Drill a hole in the bottom to fit a standard tripod screw, to which the box may be fastened with another wing nut.

Partition the inside of the case with one or more pieces of cigar-box wood for the camera and other articles. The inside may be lined with a heavy cloth and the outside covered with cloth or imitation leather, or painted. Two of the accompanying photos were purposely taken before this was done in order to show the construction more clearly. A handle may be added if desired.



The box may be covered or painted to improve its appearance. Here it is in use as a tilting top

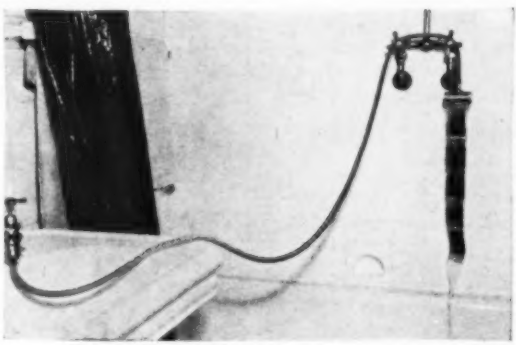
Sparing Use of Acetic Acid Urged as War Uses Create Scarcity

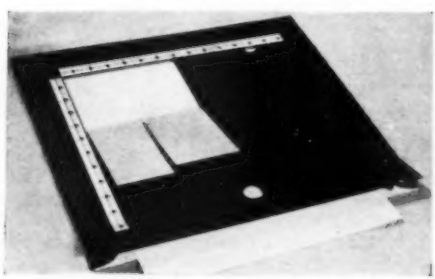
ACETIC acid, too, is helping win the war. Its uses are making it increasingly scarce, trade reports indicate. As a consequence, photographers, some of whom formerly used it with a lavish hand, are being advised to employ only the minimum quantity required to check development and acidify the fixing bath.

FOR CAMERA USERS

A PHOTOGRAPHIC EXPOSURE COMPUTER which will help photographers judge correct exposure time and camera lens opening—in any part of the world and at any time of the day in any month of the year—was recently completed by the American Standards Association. While it was prepared especially for Army and Navy use, a civilian edition will be issued in the form of a 24-page booklet with a movable dial calculator. Latitude, time, illumination, type of subject or scene, characteristics of film, and type of negative desired are all taken into consideration. The user finds from certain tables a figure called the "light index." From another table he selects a figure representing the "scene index." He adds these and sets the calculator dial so that a third figure, representing the exposure index or film factor, is opposite the sum of the first two. From the lower scales on the calculator he can then read directly the lens openings for various shutter speeds. Instructions are also given for photographing interiors or very dim exteriors, electrically lighted interiors, dawn and dusk scenes, landscapes with smoke or snow, and close-ups. Photoflash and photoflood tables are included.

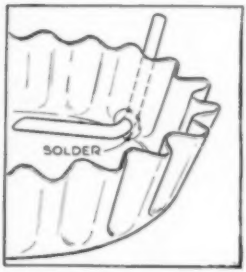
THIS COMMERCIAL FILM WASHER makes that phase of developing easier for the amateur who has to use a bathroom as his darkroom. The device is connected with a faucet by means of a rubber tube and hung over the bathtub on any convenient projection that is high enough to keep the end of the film from touching. The roll to be washed is then clipped to the top, and water flows down both sides through a series of perforations. The washer is made in two sizes, one 3″ wide and the other 5″, to fit all sizes of roll film.





ONE NONMETAL ENLARGING EASEL recently placed on the market is constructed entirely of stiff mounting board with a hard, lacquered cloth finish. It is designed as an envelope with an open end into which the printing paper is inserted. On the exposure side is a series of flaps that lift up to form a window of the dimensions desired for printing. These flaps are arranged sectionally in standard sizes up to 11″ by 14″ and also include smaller flaps suitable for making test strips. Their use gives sharp borders and does away with adjustments.

Water enters this washer through the bent tube and flows over the outer edges of the flutes. The higher inner edges keep prints in



Farm-Stock Feed Pan Serves as Efficient Print Washer

LISTED in mail-order catalogues as a "seamless hog pan" and also sold for a few cents at rural hardware stores, this pan can be transformed into a print washer that will handle a number of 8" by 10" or smaller prints. It is made from 24-gauge galvanized steel with no soldering or seams, has fluted sides, measures about 17" in diameter at the top and 14" at the bottom, and is 3½" deep. The flutes prevent continuous swirling of prints, giving a sort of intermittent motion, and their inner edges, being higher than the outer, keep the prints inside the pan as the water overflows. An 8" length of ¼" inside diameter copper tubing is bent, passed as shown through a hole drilled in the pan at the bottom edge, and soldered. The inner end of the tubing is sawed at an angle to direct the water toward the side.

It is a good practice to anneal copper tubing before bending by heating it to a dull red and quenching in water or the electrolyte from an old storage battery. If a short length of steel rod of the same diameter as the tubing is run through the hole and the end pushed in, the hole can be "twisted" to accommodate the tubing at the angle shown.—EDWARD J. THATCHER.

Two dowels, sanded very smooth and taped loosely together at one end, serve as a print straightener

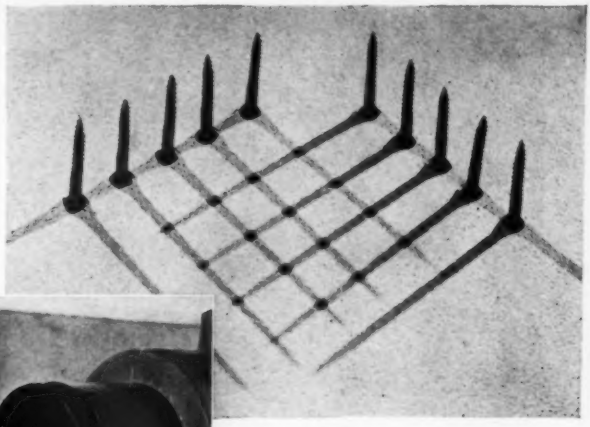
Prints Straightened Quickly with Pair of Dowels

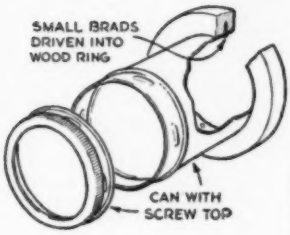
TWO ⅜" or ½" wood dowels, sanded smooth and taped loosely together at one or both ends, will quickly take the curl out of single-weight or double-weight prints. Slip the end of each print between the dowels and pull it through, bending it over one dowel in the direction opposite its natural curvature. The dowels may be waxed or given a thin coat of varnish or shellac if desired to reduce friction.

Measuring Linear Enlargement

TO DETERMINE for what linear magnification a photographic enlarger is focused, put a short transparent ruler in the negative holder, and measure the image of a 1" division on the easel with a second ruler. If it measures 3½", the magnification is 3½ diameters, and so on. An old film on which a 1" long scratch has been made may be used instead of a ruler.—FRANK E. WARE.

Diaphragm Stops in Spotlight Give Control of Shadows





MANY homemade spotlights are in use, but none of these can be regarded as complete until equipped with either an iris diaphragm or diaphragm stops.

An accompanying photograph and the drawing show an easy method of attaching sheet-metal disks with holes in them over a spotlight lens to serve as stops. The bottom is cut out of a can of approximately the same diameter as the lens, and it is attached over the lens by means of a wood ring. The can should preferably be of the kind having an interrupted thread or bayonet-type top so as to save time when it is desired to change from one disk to another. The lid is cut out so that it forms a flange for holding the diaphragm stops.

This fitting is suitable for other uses. For example, several diffusion disks may be made to soften the light. These may be of fabric cemented to a ring of sheet metal or cardboard so as to be interchangeable with the aperture disks.

A similar arrangement on a camera will hold filters and diffusion screens. If a tin-can tube is cut to the correct length, it will form an excellent lens hood. The device would even serve as a satisfactory effect-mat box of the type used for special effects.

The advantage of being able to stop down a spotlight is that it permits very much greater shadow control. In the photograph of the wood screws, only one spotlight was used. The two lines of screws were first set up as shown. The spot, with a small aperture, was placed so as to be in line with one row, and the camera shutter was opened for half the calculated exposure, then closed. Next, the spotlight was moved over until it lined up with the other row of screws, and the remainder of the exposure was made. In such work be careful to keep the spotlight approximately the same distance from the objects each time or the shadow density will vary.—R. O. LISSAMAN.

Faults in Negatives Due to Overexposure and Underexposure

MODERN films have a wide exposure latitude, but few amateurs realize the difference faulty exposure makes in the quality of negatives. Overexposure causes large grain, loss of high-light detail and contrast, dense negatives, and a reddish hue in color films. Underexposure results in loss of the full-tone scale, too much contrast, lack of detail and shadows, thin negatives, and a bluish hue in color films.

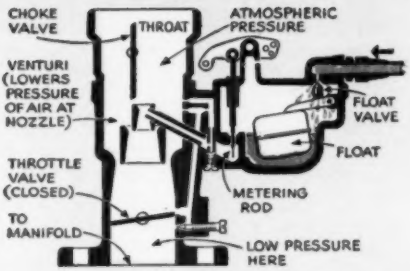
Carburetors Need Care

KEEPING carburetors perking properly is of utmost importance to motorists today. Where strict fuel rationing is in effect, and wherever motorists are observing a self-imposed fuel economy, a good carburetor in good condition is worth as much as a generous extra measure in your gasoline tank.

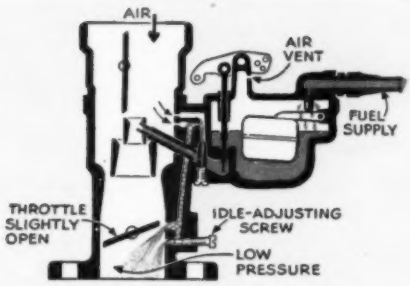
Carburetors, first, must be clean. Second, they must be in good mechanical condition. Third, they must be properly adjusted, but the last is strictly a qualified statement. Idling adjustment, for example, is easy. But adjustment for the best running economy is not only difficult, it is impossible without taking the carburetor apart.

This much-neglected part of your car is really an atomizer in which both the liquid spray and the air blast are subject to volume control. Both controls work from the same lever—your foot accelerator. The flow of air rushing down through the carburetor

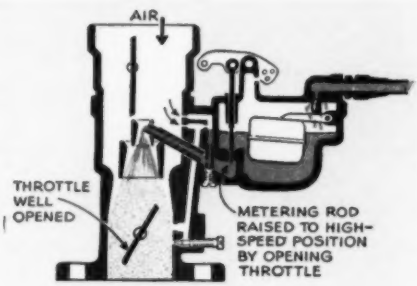
THE FIVE CARBURETOR CIRCUITS. No. 1 is the float circuit. Gasoline pumped into the float bowl raises the float, gradually closing the float valve, preventing the carburetor from flooding. No. 2 is the low-speed circuit, for idling and no-load speed up to 20 miles an hour. Then No. 3, the high-speed circuit, takes over. Meanwhile a stepped metering rod has lifted automatically in a valve, admitting more gas from the bowl to the jets. No. 4 is the choke circuit. To operate, its choke valve must be closed, limiting the air supply and thus sucking extra fuel through the jets for easier starting. No. 5 is the acceleration-pump circuit that supplies extra fuel for good pick-up when you step on the gas



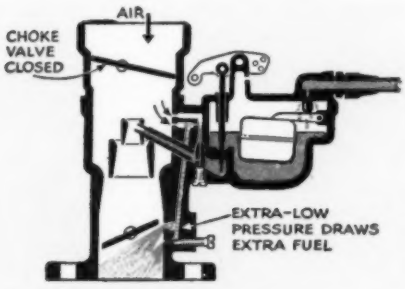
1 FLOAT CIRCUIT. It keeps the bowl filled to the level of the end of the high-speed jet, maintaining an even fuel supply



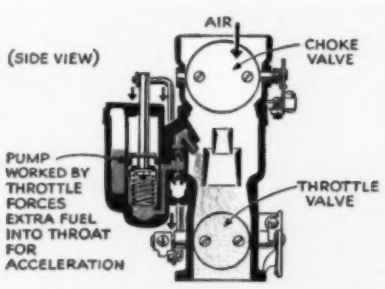
2 LOW-SPEED CIRCUIT. Note that the fuel (colored) mixes with air and then flows into throat below the closed throttle



3 HIGH-SPEED CIRCUIT. Throttle is open, and air-saturated fuel is flowing only from high-speed jet into air blast



4 CHOKE CIRCUIT. Virtually shutting off atmospheric air greatly lowers the pressure at idling jet, pulling in extra gas



5 ACCELERATION-PUMP CIRCUIT. It is operated by the throttle. Without it, engines would buck when it was least desired

throat, for example, is regulated by a throttle valve. Gasoline for the nozzles feeding this throat is regulated by a valve coupled to the throttle lever, or by changing air pressure. A critical quantitative air-fuel ratio at all speeds and loads is thus maintained automatically by the carburetor. Upsetting this ratio kills engine efficiency, makes your car hard to start, reduces power by a dozen different effects. In short, it wastes gasoline. The upsetting of the ratio comes from a dirty air cleaner, or from dirty nozzles and tubes and worn controls within the carburetor. To correct it requires that the carburetor be removed, dismantled, cleaned, and its vital parts serviced.

Some of these parts are so small and their dimensions so important that carburetor makers recommend replacing them when they become worn, rather than trying to repair or reshape them. Moreover, the principal cost of overhauling a carburetor is a

IMPORTANT STEPS IN A CARBURETOR OVERHAUL TO RESTORE

1 A soaking in a strong solvent is necessary to remove the carbon and dirt from the parts of a dismantled carburetor

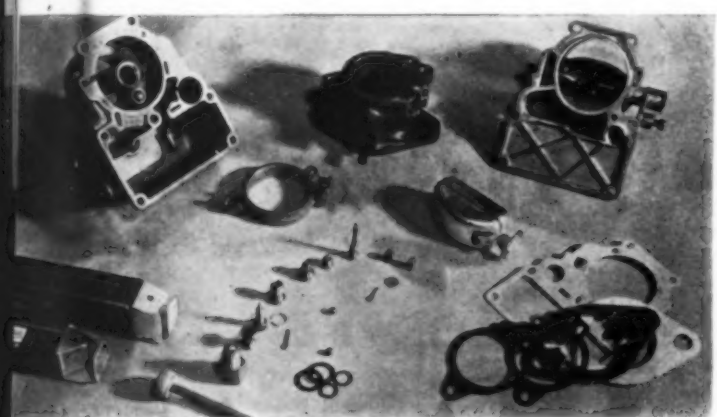
2 Installing a new high-speed jet in a carburetor. When its tiny openings become clogged, efficiency nose-dives

labor cost, so the makers urge replacing all parts subject to gas-wasting wear whenever any one part is giving trouble. Kits containing such parts are available.

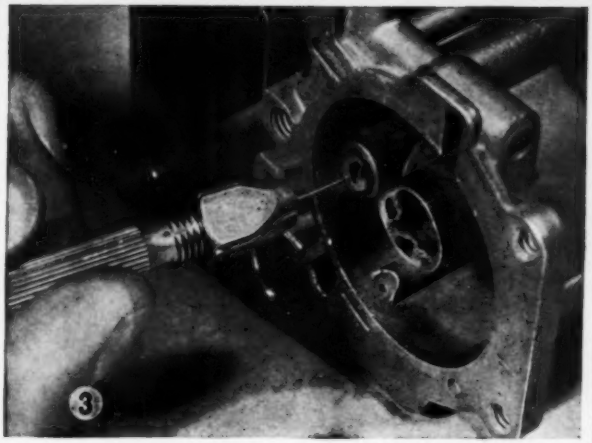
In the accompanying simplified drawings, what one manufacturer calls the five "circuits" of an automobile carburetor appear, with the gasoline flow of each circuit represented in color. It will repay the motorist to study them. While many automobiles have "dual" carburetors, containing two throats and two complete sets of jets, and while one even has twin dual carburetors for a total of four throats, all of them work the same. Air sucked in through the air cleaner by the low pressure in the engine's intake manifold atomizes and mixes with the gasoline and flows to the cylinders for compression and burning. At idling speed, there should be about eight parts by weight of air to one of gasoline. On the road, depending upon speed and load, the mixture runs between 12 and 16 parts by weight of air to one of gasoline. It is when wear and dirt upset this mixture that driving economy is destroyed and an overhaul is required.

Just dismantling a carburetor and washing it with gasoline is a waste of time, for much of the dirt that forms in carburetors stays there simply because it is insoluble in gasoline. Stronger stuff is needed. A well-equipped shop usually has a tankful of it off in a well-ventilated corner with caution signs warning that it is poisonous.

In such a cleaner all carburetor parts should be soaked, then wiped clean and dry. Often, new specifications for nozzle, or jet, diameters, or for other critical adjustments, have been put in the hands of your service man by the carburetor maker to suit changing gasolines or to increase engine efficiency. This is just one of the several reasons why an authorized dealer or service shop should get your carburetor work. Others are that such shops have the proper parts, the tools for installing them,



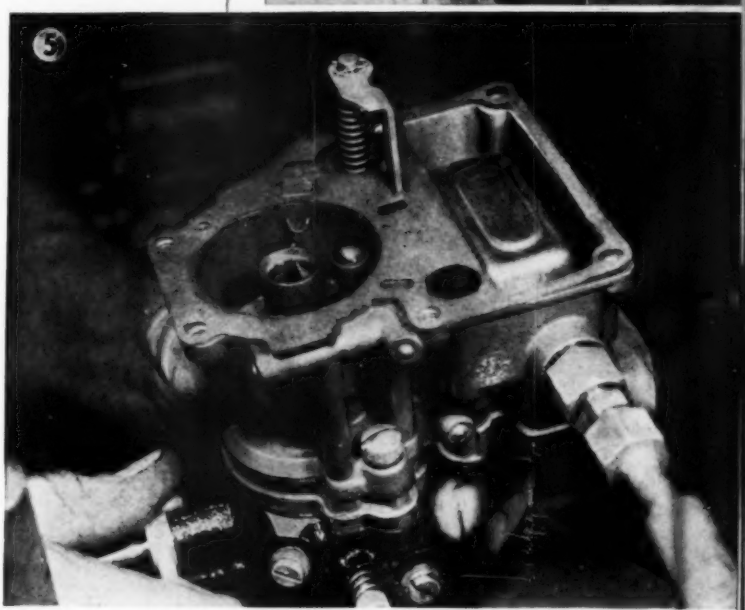
At lower half of the picture, the gaskets and small parts of a carburetor that are better replaced than repaired are shown. Makers pack them in kits with everything required for complete overhaul



3 Reaming an air-bleed hole in the high-speed circuit with a drill. It is a delicate job no amateur should try

4 How the float level is fixed. At a critical distance from the top of bowl, the float valves in just enough fuel

5 To test the flow of fuel as it leaves the acceleration pump, the throttle is worked (lower left) and fuel flowing from a graduated tube, not in picture, is carefully meas-



and trained workers with knowledge of what the overhaul is for—restoration of the carburetor to peak efficiency.

Carburetors should be serviced at least once a year, or every 10,000 miles, oftener if you make many short trips or drive in dusty areas. Their usefulness can be extended by having the air-filter cleaned and re-oiled according to your instruction book or the instructions printed on its side. In cleaning carburetor jets and nozzles, the tiny holes should not be reamed out with wire or drills unless of proper diameter, and even then with utmost care. Some of the holes should be cleaned only with a compressed-air jet. It often is better to install new parts than to attempt to clean the old ones. Then you know they will be right. Old gaskets separating the carburetor-body sections should never be put back, but should be replaced with new ones.

Most important of all, it should be remembered that a carburetor is a complicated chain of interconnected parts, all closely dependent upon one another. One bad part can destroy the proper functioning of all.

A complete carburetor overhaul costs somewheres around $6, on the average, for a medium-size car. A worn-out, neglected carburetor can cost ten times that in wasted gasoline in a year. Wasting gasoline today is as foolish and dangerous as wasting guns and airplanes.—SCHUYLER VAN DUYNE.

Stretchers, mattress, and flooring equip this coupe for conversion into an ambulance in a few minutes

With the seat back removed, the flooring is laid between the seat and the spare tire in turtleback

Coupe Makes Emergency Ambulance for Three

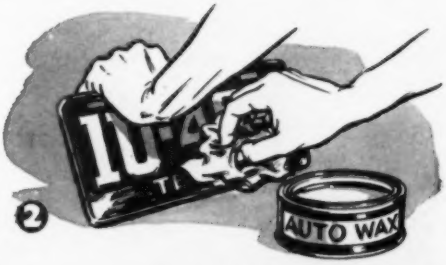
BY REMOVING the cardboard partition between the front section and the turtleback of his small, four-cylinder coupe, a Los Angeles civilian defense worker has prepared the car for prompt conversion into an emergency ambulance. With the seat back taken out, a plywood floor six feet, seven inches long and three feet, 10 inches wide is laid across the space between the seat and the spare tire to accommodate a mattress or two stretchers. So equipped, the car will carry two adult patients, with a child on the shelf under the rear window. Driver and attendant ride on the seat. Made in two pieces, the plywood floor can be carried in the car at all times, along with the stretchers and mattress, ready for instant use whenever and wherever the need may arise.

More than six feet long, the space will take two adults on stretchers, with plenty of room to spare

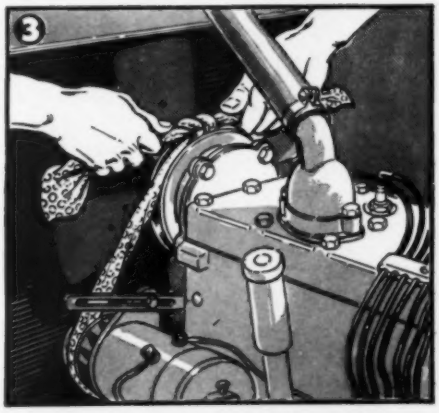
A child can be placed on the shelf under the rear window. Driver and attendant ride on the seat. The only structural change needed was to remove the cardboard partition and the cross-bracing members between the seat and turtleback

IDEAS FOR MOTORISTS

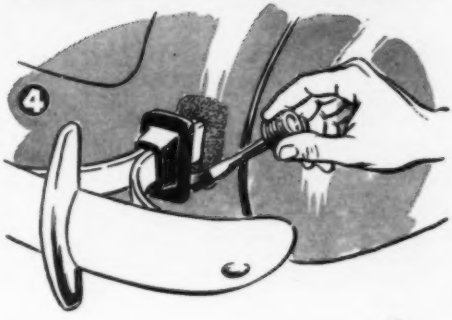
1 PROTECTIVE INSULATION for the hood of a car is provided by applying one or two coats of aluminum paint to the underside, as illustrated above. The paint, which can be obtained from most hardware stores, slows the progress of the engine heat upward, thus lengthening the life of the paint or enamel finish at the point where it usually deteriorates first and fastest on an aging automobile.—G.W.P.



2 YOUR LICENSE PLATES, formerly finished for an expected life of no more than a year, may need extra care to keep them in condition for several years of use under the wartime metal-conservation program adopted by most states. An occasional thorough waxing with automobile wax will help keep them in good condition.—D.B.J.



3 AN EMERGENCY FAN BELT that will get you considerable distance to a garage if you are caught with a broken belt and no spare can be contrived from a necktie. Pull the ends fairly tight and secure them with a square knot. Don't race your engine and don't drive your car more than 10 or 15 miles an hour.—B.H.



4 LOOSENED RUBBER PADS on bumper arms, lamp brackets, and the like, should be tightened promptly. To do this, clean the surfaces with gasoline, let them dry, and apply running-board cement to both surfaces. Clamp solidly until dry.—J.N.

DRAWINGS BY STEWART ROUSE

Auto Ideas

PAINTING MILES ON TIRES is now possible with a new type of liquid made from synthetic rubber that is simply put on with a brush. Any number of coats may be applied, each after the previous coat has dried. As shown in the illustration at the right, the substance is applied directly to the tread of a tire to build up a new traction surface. The dried material resembles rubber, and is said to add many miles of wear to the life of a tire.

FLAT-TIRE WARNING is given to the driver of a car equipped with the novel invention of a Mayville, N. D., motorist. The device consists of a length of wire locked to the wheel by a special lock. When the tire becomes deflated beyond a predetermined point, the lock springs open, releasing one end of the wire. Thus loosened, the wire leaves the rim and the revolving wheel causes it to bang against the fender or fender well of the car in unmistakable warning that the air pressure in the tire is getting low. How the gadget is mounted on the rim of a car wheel is illustrated at the left.

A PORTABLE WHEEL ALIGNER just introduced is particularly useful in small shops where floor space is at a premium. The unit, which any mechanic can use, checks camber, caster, and toe-in. The protractors that show camber and caster (left, below) are quickly fastened to the wheels by small clamps. The toe-in trammel bar (right) is of direct-reading type and is adjustable to different wheel treads. An angle gauge which is used with the trammel bar sets the wheels at the correct angle for properly reading steering geometry angles, and the whole unit takes up little storage space.

He took three large tablets and dropped them into the gas tank. Then he got into the car and stepped on the starter. The engine took off

Trouble comes double

But some people, Gus Wilson believes, deserve it. Especially if they neglect their cars and likewise play practical jokes

By MARTIN BUNN

IT was getting close to four o'clock, and Gus Wilson, who had been busy all day, admitted to his Model Garage partner Joe Clark that he was just a little bored. "Plenty of work," he told him, "but it's all run-of-the-mine keep-'em-rolling jobs."

"Yeah," Joe said scornfully, "I know just the kind of job you'd like to have someone bring in here—something you could spend an hour fooling with, and then charge the customer for ten minutes' time and a quarter's worth of materials. You ought to be running an experimental laboratory, not what's supposed to be a money-making business!"

Gus grinned at his partner. "Speaking of money-making business," he said, "someone's been honking his horn out at the pump for the last couple of minutes. You'd better get out there and collect his pennies!"

Joe growled something under his breath and hurried out. But after a minute or two he stuck his head in at the open shop door, and Gus was astonished to see that there was an expression of something that looked like awe on his bespectacled face.

"Ps-st!" Joe warned. "Come on out here—step on it! That fellow at the pump asked for some water, and when Wally gave him a can of it he emptied it into his *gas tank*. Then he dropped in three yellow tablets. And then he asked me could he use the phone. He's in the office now. Hurry up out here and see what happens when he tries to start his engine. By golly, if it runs on those tablets it means that he's found out how to beat the gas short-

age, and there'll be millions of bucks in it!"

Gus didn't waste any time in getting out to the pump. Wally, his mouth gaping open, was staring at a sedan with Colorado tags—a car which looked as if it had been driven plenty hard and which apparently hadn't been washed since the day it had been driven off the dealer's floor. A tall, thin man with stooped shoulders and a wide-brimmed felt hat shading a long, solemn face came out of the office. He started to get into the car, changed his mind, and asked Wally for some more water. When the grease-monkey gave it to him he emptied it carefully into his gasoline tank. Then he took a small tin box out of his pocket, extracted three large yellowish tablets from it, dropped them into the gas tank, and screwed on the cap. Then he got into the car and stepped on the starter. The engine took off at once. It pinged and it seemed sluggish—but it kept on running.

The solemn-faced man looked over at Gus and Joe. "Thanks, gents," he said. "Thought I might as well fill her up while I was at it—it don't cost any more, and now I won't have to stop for gas for a couple of days."

"Hey, mister," wide-eyed Wally gasped, "do those pills you put in your gas tank really run your motor?"

"She runs, don't she?" the man in the car demanded. "That's good enough proof, ain't it?"

"Where can you buy 'em—those gas-pills?" breathless Wally wanted to know.

"I ain't put 'em on the market yet," the man told him. "But I'll tell you how you can make some. You take . . ."

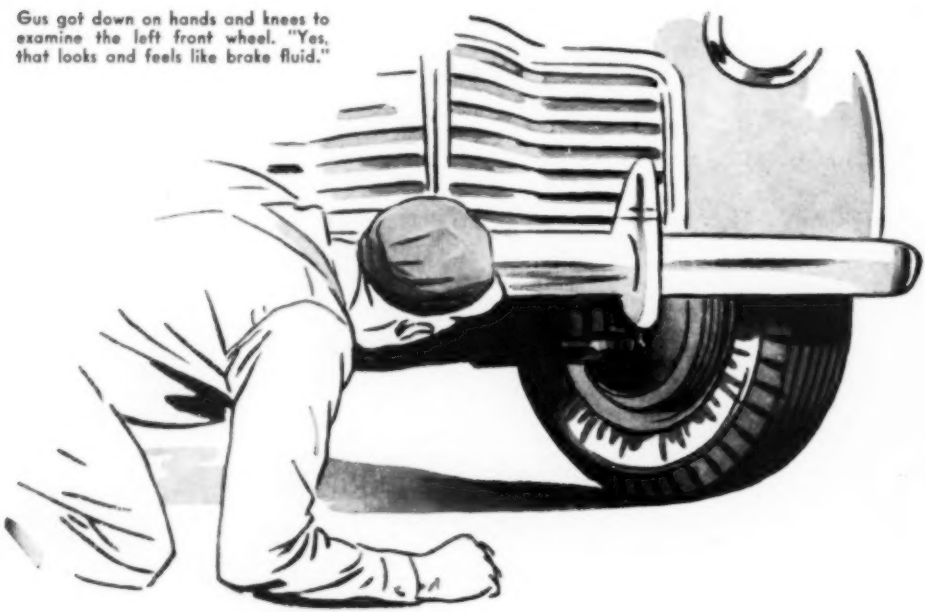
"Wait a minute, mister, will you?" Joe cut in. "Just wait until I get a pencil and a piece of paper!"

He started for the office door, but Gus caught his arm. "Don't bother, Joe," he said, and turned to the thin man. "Same old Bill Osgood, aren't you? As big a kidder as you were out in Cripple Creek 20 years ago. How's that mine of yours doing?"

Osgood's solemn face crinkled into a hundred deep wrinkles as he laughed and shoved out a skinny hand. "I knew you the minute I set eyes on you, you old buzzard!" he told Gus. "But I didn't think you'd recognize me, so I thought I'd put one over on you before I told you who I was—just for the sake of old times. My ol' mine's doin' right good—so good I can take off all the time I want to. That's how come I'm in these parts. I'm visitin' my daughter and son-in-law up the road a piece."

Gus jerked a thumb toward the battered car. "What's the gag this time?"

"Jest a laugh-getter, that's all," Osgood explained. "Folks out east here are too



Gus got down on hands and knees to examine the left front wheel. "Yes, that looks and feels like brake fluid."

danged serious for me. I like a joke. Boy, those gas-pills of mine leave 'em gaspin' when I drive away. A couple of days ago I got in a little smash-up, and it sprung a leak in my gas tank. Hearin' everyone talkin' about the gas shortage gave me a big idea, so instead of gettin' my tank fixed I had an old one rigged up in the baggage compartment. Then I bought me a box of cough lozengers, and ever since then I've been workin' this gas-pill stunt for all its worth—and maybe a lot of you wise-guy Easterners ain't fallen for it. But, first off, I come in here on business—feller down at the station told me it was a good place to have a job done. I'm havin' a little trouble with my brakes—the brake fluid's gettin' away somehow, I guess. That's how I come to get in that little smash-up."

"What's this—another of your fool jokes?" Gus demanded suspiciously.

"No, sir!" Osgood proclaimed loudly.

"All right," Gus said. "But just remember that we're charging you for time from this minute on. Drive that bus of yours into the shop, will you?"

Osgood drove into the shop, and Gus noticed that he stopped his car by pulling on the hand brake. "How long is it since you've had anything done to your brakes?" he asked.

"Ain't never had anything done to 'em except adjust 'em once or twice," Osgood said. "Ain't never had any trouble with 'em until the last couple of weeks." He got out of the car, produced two cigars from a vest pocket, and held them out to Gus. "Have a see-gar," he invited.

Gus shook his head. "Those trick-shop cigars of yours were a stale joke 20 years ago," he declined scornfully.

Osgood grinned and put the phony cigars back in his pocket.

Gus got into the car and stepped on the brake pedal. It went right down to the floorboard. "You're right about losing brake fluid," he said. "You've lost so much that there's mighty little, if any, left in the system. Have you been using your hand brake altogether?"

"What's wrong with a good hand brake?" Osgood demanded.

"Someday you're going to drive yourself right into a graveyard," Gus said grimly. "Worse than that, you're going to drive some people who aren't as big fools as you are into one. A man who drives a car with brakes as bad as these ought to have his license taken away from him! He's a public menace! Well, let's find out where that fluid is getting away."

"That front wheel's been sort of wet lately," Osgood suggested. "Looks to me like the fluid is leaking out past its brake drum."

Gus got down on hands and knees to examine the left front wheel. "Yes, that looks and feels like brake fluid," he said. He pulled off the wheel and examined the brake mechanism. Then he whistled.

"Well, what about it?" Osgood inquired.

"You're a wonder—a real wonder," Gus told him. "You're undoubtedly the world's worst automobile driver. You've done something which, so far as I've ever heard, no one else ever has been fool enough to do. You're so bad you're remarkable!"

Osgood seemed to feel flattered by this caustic tribute. "That so?" he said. "What did I do?"

"You wore all the lining off your brake shoes," Gus said. "Then you went on using your brakes with the shoes bare. That wore down the shoes. Now, by golly, the shoes are gone, except for the inside reinforcing ring. You've let the pistons right out of the wheel cylinders—and all the brake fluid out of the system."

Osgood grinned. "Say, I made a right good job of it, didn't I?" he remarked with satisfaction. "Well, you better fix things up, Gus—all four brakes, while you're at it. And there's something else on this car that ain't working just right."

"There would be," Gus said. "Trouble comes double to a driver like you. What's your other grief?"

Osgood got in the car and started the engine. "Listen to that danged motor," he said. "What's the matter with it? It oughtn't to run thataway."

"It certainly shouldn't," Gus said, "but the way you manhandle a car, I don't wonder that it does. Probably it is something wrong with your distributor that is making the engine miss."

"That's right," Osgood said. "By gum, I jest remembered something. A few days ago my motor got to missing pretty bad, so I stopped in at a service station to see what was the matter with it. The feller said that my rotor was worn. He didn't have a new one that he could put in, so he fixed it up somehow with a little solder, and told me that I should get a new one first chance I had.

"Well, I drove away, and the motor ran all right for a while. Then I hit a rough spot in the road, and the motor stopped. No juice. I got out and fooled around with the distributor for a while—didn't really do anything to it, because I didn't know anything *(Continued on page 220)*

HOME and WORKSHOP

MACHINISTS FOR WAR WORK

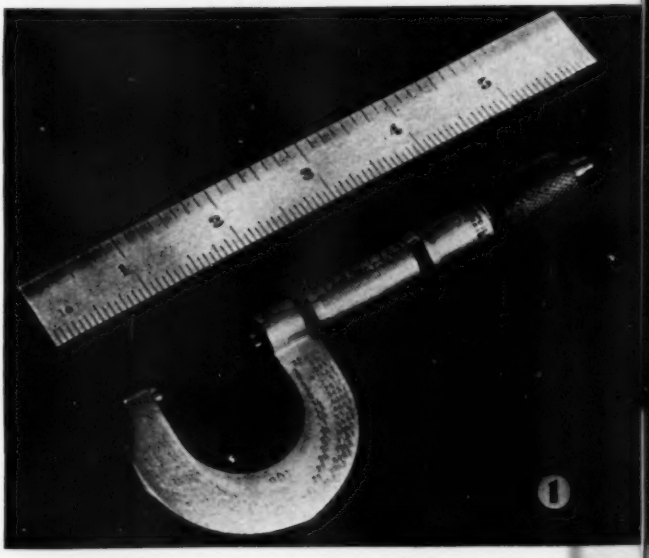
SKILLED HANDS TO SERVE AMERICA . . . FIRST OF A SERIES OF SHOP ARTICLES FOR MEN WHO ARE TRAINING FOR THE INDUSTRIAL FIRING LINE

How to Use the

Machinist's Steel Rule

From the U. S. Office of Education training film, "The Steel Rule"

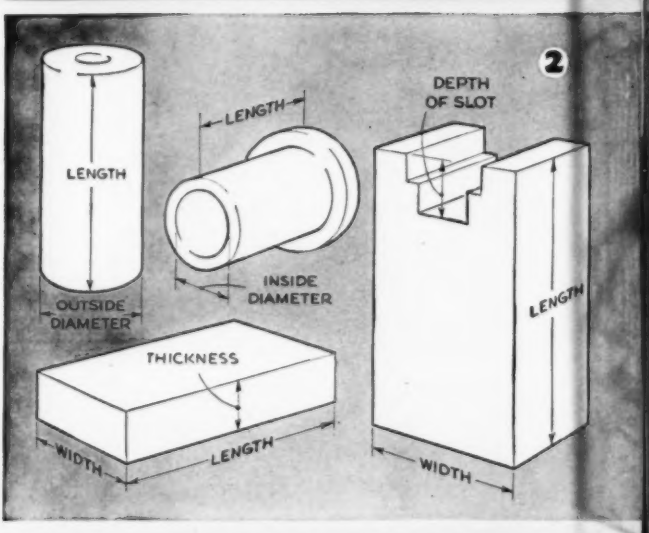
This article is based upon the first of a series of 16-mm. sound-on-film motion pictures prepared for training war workers by the U. S. Office of Education and distributed for the Government by Castle Films. For the machine-shop student or beginner, the practical value of these films cannot be overstated. They explain in the simplest and most graphic manner the principles underlying the operation of the standard tools and machines used in industry. Make every effort to see these films if they are being shown in your community.

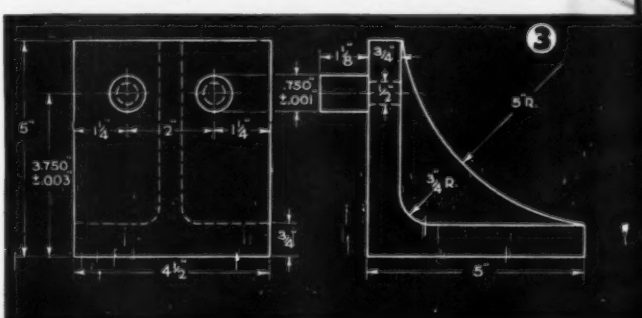


GUNS, tanks, and planes, locomotives and ships, turbines and Diesel engines, cotton gins and rotary presses, all exist only in man's imagination until they take shape on paper in the form of drawings. These guide the patternmaker, the foundryman, and finally the machinist in making parts that will later be assembled into a working whole.

In order that those parts will fit with one another, each must be checked with measuring tools at various stages to make certain it conforms to the drawing. The size and proportions of any part can be expressed by a number of dimensions, or measurements of distance (Fig. 2). Length, width, and thickness, the depth of holes and slots, inside and outside diameters, the radius of a fillet, the throw of a crank or cam, the pitch of a screw—all are measurements of distance.

To measure distances, the machinist uses tools graduated in terms of a standard unit of length, which must be precisely the same on all measuring tools. In the United States this standard unit of length is the inch.





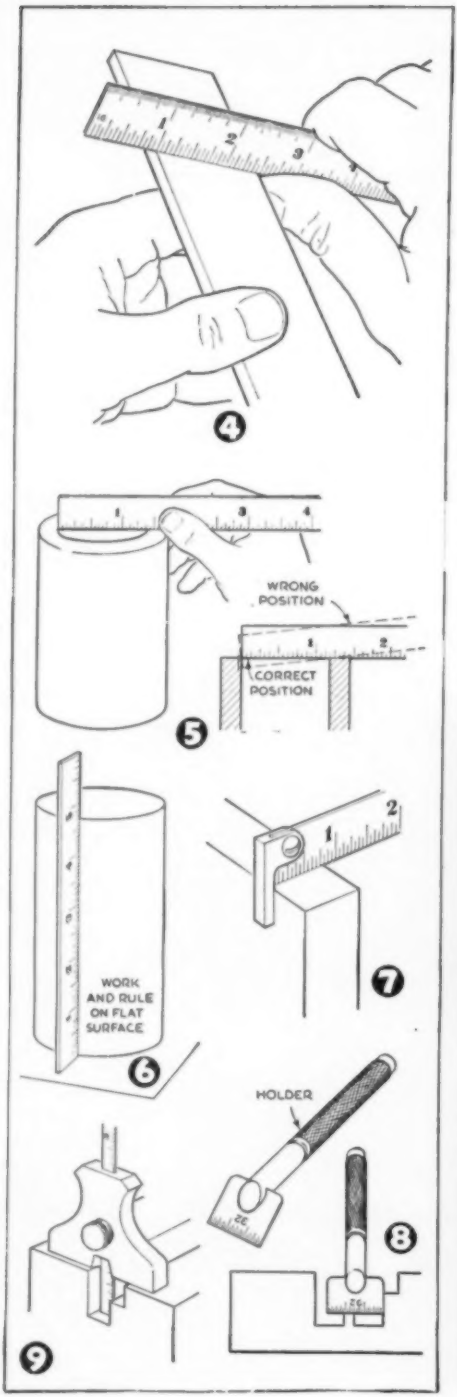
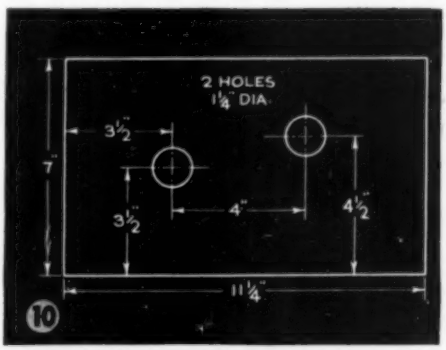
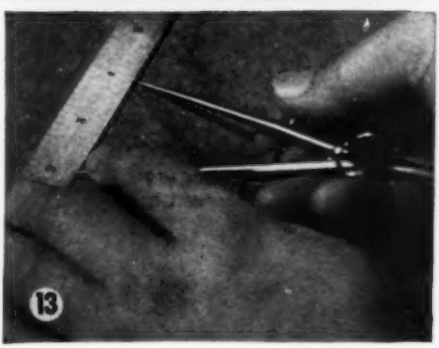


Figure 3 shows a typical shop drawing. It specifies not only all the needed dimensions, but also the degree of precision to which each must be measured. Dimensions given in fractions may be measured with a rule, since the graduations on the scale are fine enough for measuring as closely as necessary. When dimensions are given in decimals, they must be measured with a more precise tool, such as a micrometer. The steel rule and the micrometer (Fig. 1) are the two measuring tools most often used in the machine shop; the chief difference between them is the degree of precision with which they measure.

A steel rule usually has four scales graduated in fractions of an inch—in sixteenths, thirty-seconds, sixty-fourths, and one-hundredths, for example. Some rules are graduated in tenths, twentieths, fiftieths, and one-hundredths, others in twelfths, twenty-fourths, and forty-eighths, and still others in fourteenths and twenty-eighths. On some the graduations are numbered to make them easier to read quickly and to reduce the possibility of errors. Look for the identification number at the beginning of the scale (Fig. 1) whenever you measure with a rule to make certain which scale you are using.

For maximum accuracy, a rule is used





on edge—not flat like an ordinary ruler. It should be held at right angles to the edge from which the measurement is taken; slanting it across the work will give a false reading. Because the ends of a rule are most subject to wear and damage, it is good practice to set the 1″ mark at the point from which you wish to measure, as shown in Fig. 4. Subtract 1″ from the reading to obtain the actual dimension.

In measuring the diameter of a round piece, place the rule directly across the center—that is, on a true diameter. The largest reading you can obtain is the correct one. The same applies in measuring the diameter of a hole. Let the end of the rule butt up against the side of the hole, but do not tilt it any more than absolutely necessary (Fig. 5).

When measuring the *length* of a piece of round stock, be sure to hold the rule parallel to the center line. If the ends are faced true and the piece is not too long, it can be set upright on a flat surface and the rule also placed on end against it (Fig. 6).

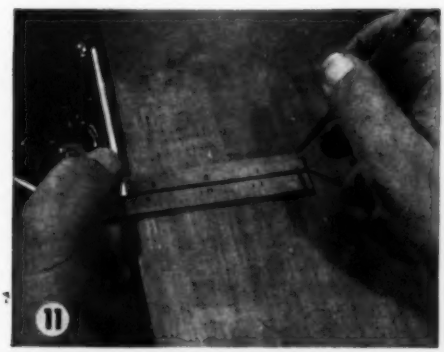
There are many kinds of steel rules, each of which has been developed for a specific type of work. A flexible one is particularly useful where the shape of a piece, or its position, will not allow a rigid one to be used. A hook rule (Fig. 7) gives quick measurements because the end of the scale is aligned automatically with the edge of a piece as the rule is brought into position. It is especially handy for measuring narrow widths, such as from a shoulder.

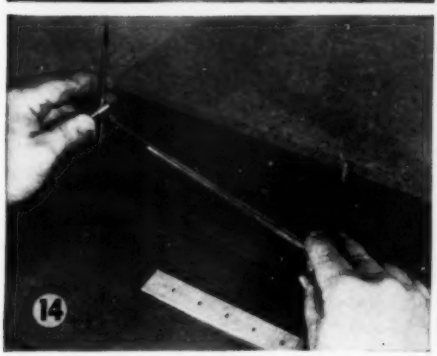
The slide caliper rule, handy for taking quick measurements of tubing, rods, and the like, resembles the hook rule but has in addition a movable jaw that can be slid against the hook to measure stock between contacts.

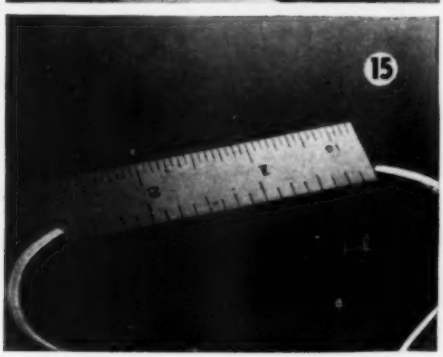
Another kind of steel rule, shown in Fig. 8, is not so easily recognized. It consists of very short interchangeable rules that can be mounted in a holder for use in close places. Each is marked with a figure showing how it is graduated.

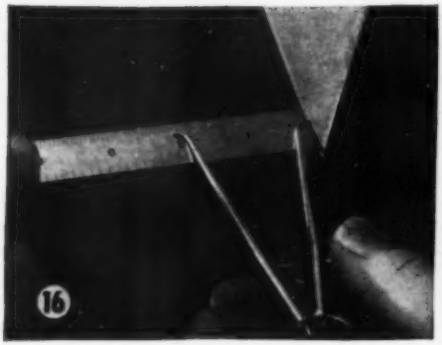
The rule depth gauge in Fig. 9 is useful for measuring slots, holes, and the depth of keyways. Always hold it at right angles to the face of the work in both directions, and lock the clamping screw before removing the gauge to take the reading. The narrow rule will enter holes as small as 3/16″.

An important adaptation of the steel rule is the combination square. It is very useful in layout work—that is, in marking a piece of stock for machining. As a specific example, let us take the steel plate shown in Fig. 10. Two 1¼″ holes are to be drilled in it. Their location is given by measurements taken from the finished edges of the plate.









To make the layout lines more visible, the steel may be swabbed with a solution of copper sulphate, which deposits a very thin, reddish film of copper on the surface.

One hole is 3½" from the narrow working edge, and also 3½" from the long edge. The head of the combination square is therefore set 3½" from the end. Slide the rule in until only half of the 3½" index line is visible. Take a scriber and, holding the head of the square against one edge, scribe the line on the work against the end of the rule (Fig. 11). The groove in the rule should be up, otherwise the point of the scriber will slip into it and off the line.

The combination square need not be reset for the other dimension, as it happens to be the same. Set the head against the other edge of the work and scribe another line, crossing the first. This locates the first hole.

As the second hole is to be 4" from the first, the rule is now set to 4" more than 3½", or to the 7½" index line, and the line is scribed from the short edge. Finally, the rule is set at 4½" and the cross line of the second hole is scribed from the long edge.

The point at which a pair of lines crosses is dotted with a center punch. Use a magnifying glass, as shown in Fig. 12, to set the punch accurately. Tap lightly with a hammer—a heavy blow will shift the mark off center.

Let us assume that the holes are to be scribed on the work. Dividers are used for this. To set them to the required radius—⅝" in this case—set one point in an inch graduation on the rule and adjust the nut so that the other point falls into the ⅝" graduation. Set one leg in the center-punched marks and scribe the circles.

Divider points must be sharp for accurate work. If they are dull or bent, they cannot be set properly. Some men prefer to hold the dividers at a slant, as shown in Fig. 13, instead of upright. Either way is correct.

The trammel or beam compass (Fig. 14) is used for laying out large radii. Its two points are adjustable on a bar or beam, and are set in the same way as dividers.

A steel rule is commonly employed for setting outside calipers. Hold one leg firmly against the end of the rule and set the other leg to the center of the proper graduation (Fig. 15). In using the calipers to check the work, never force them over; this would result in a false measurement. The legs should pass over the work with only a slight drag—just enough to indicate contact. Never caliper work while it is turning in the lathe. The motion may pull the calipers over even though the work is still oversize, and thus give a false measurement. Always stop the lathe first.

The outside calipers are also frequently used to measure work indirectly by setting them to the work, then reading the setting against a rule.

Companion tool to the outside calipers are the inside calipers, which are used for measuring inside dimensions. To set them, place one leg and the end of a rule against a solid surface (Fig. 16) and adjust the nut to bring the other leg to the center of the right graduation. Inside calipers can also be set with the combination square, one leg being placed against the head. Figure 17 shows inside calipers in use for checking the diameter of a hole. The right "feel" as the points drag slightly tells the operator whether the hole is the same size as the calipers are set for.

Remember, when setting dividers or calipers by means of the steel rule, that both points or legs should be the same distance back from the edge of the scale.

The usefulness of any tool, even such a simple instrument as the steel rule, is maintained by proper care. Keep it where it will not be dropped or have heavy tools thrown on top of it. Wiping it occasionally with an oily cloth will prevent rusting and keep the graduations clean and easy to read.

Toy Army Tank

By CHARLES and
BERTRAM BROWNOLD

A REALISTIC toy Army tank that will delight the heart of a young tank driver can be made of plywood and small pieces of hardwood. No metal parts are needed except a few nails and screws. Its construction is so simple, and it takes so little time, effort, and money, that it is an ideal Christmas present.

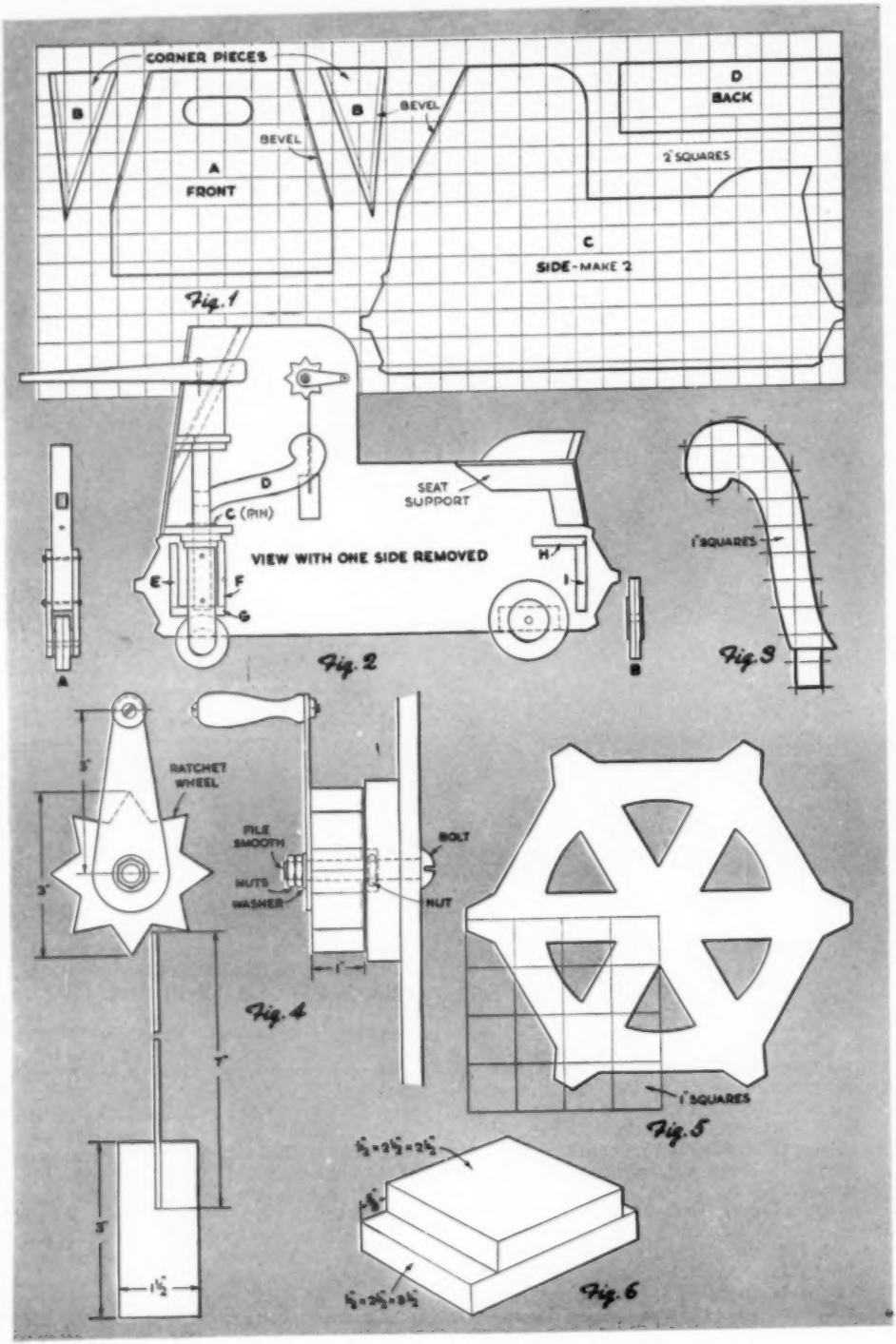
The tank has no bottom, and the driver propels it with his feet, which reach the ground.

Body. Make the front, back, and two sides of ¼" plywood, cut to the shapes shown in Fig. 1, patterns of which can be made by following the outlines on 2" squares. The two sides are identical except for the bevel, and can be cut out together at one time.

Two triangular corner pieces, a right and a left, are needed. They are cut from ¾" hardwood. The tank is assembled with roundhead wood screws driven through the plywood into these corner pieces and into hardwood blocks at the four corners.

Wheels. The tank has three wheels. Wire or metal ones from a discarded go-cart, a wagon, or some other toy will do. If none of this type can be found, it is easy to make wheels of hardwood. They should be thicker at the center than at the circumference, just as wire and disk wheels are. Thickness at the center prevents wobbling on the axle, while thinness elsewhere makes for lightness. Each wheel is made of two large and two small disks glued and screwed together, as shown at *A* and *B* in Fig. 2. The grain of each disk should run crosswise to the grain of the next.

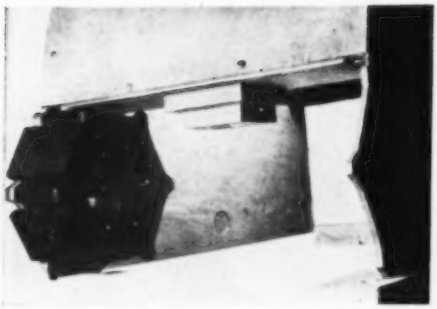
The rear *(Continued on page HW 324)*


CORNER PIECES
B
B
BEVEL
BEVEL
A
FRONT
D
BACK
2" SQUARES
C
SIDE - MAKE 2
Fig. 1
D
C (PIN)
SEAT SUPPORT
VIEW WITH ONE SIDE REMOVED
E
F
G
H
I
A
B
Fig. 2
1" SQUARES
Fig. 3
3"
3"
RATCHET WHEEL
FILE SMOOTH
NUTS
WASHER
BOLT
NUT
1"
Fig. 4
1" SQUARES
Fig. 5
1"
3"
1½"
½" = 2½" = 2½"
½" = 2½" = 2½"
Fig. 6

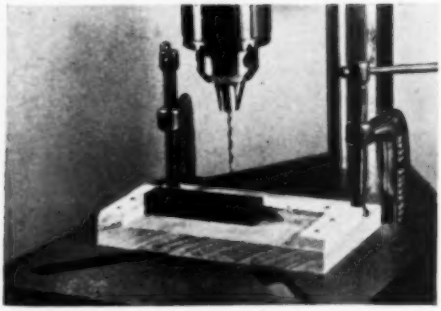
To permit steering by the little tank driver, a fork for the front wheel is made from two flat pieces of hardwood bolted to a short hardwood pole. The handle is glued after final assembly

At right, the gun is being installed. The one here is a nickel baseball bat with part of the handle sawed off. A noise-making ratchet, shown inside the front section, simulates the noise of the firing of the gun. Steering and seating arrangements may also be seen

Rear wheels are free to revolve on the axle, the ends of which fit into holes in the axle blocks shown below. The blocks above and behind the wheels are for mounting the tread sprockets

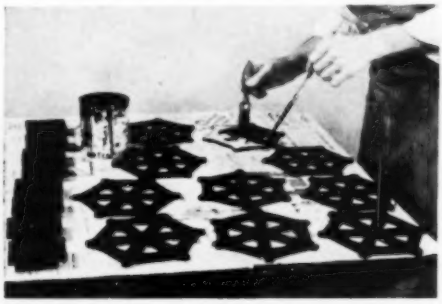


This front assembly shows an inside sprocket in place, with the front treads nailed on, and two of the supporting blocks for the steering fork



With this jig, the 36 small treads can be drilled at both ends by simply shifting them. The boring of nail holes prevents splitting during assembly

Dipping saves time in painting the small treads. They may be done singly or several may be stirred in the paint at once. Dry them on scrap blocks



Sprockets and large treads should be painted flat on newspapers covering the bench. A stick held against them, as above, keeps them from sliding

wheels must turn freely on their axle, which may be a hardwood broomstick or dowel, and are held with washers and cotter pins. The axle fits into holes in blocks, which are screwed fast inside the sidepieces, as shown in Fig. 2.

Steering fork. A fork is made for the front wheel of two flat pieces of hardwood bolted to a short length of hardwood pole, as is also shown in Fig. 2 and in the accompanying photographs. This steering post passes through a hole in a shelf screwed to the front and sides of the tank, and its upper end fits into a socket consisting of a block, in which a hole is bored, screwed to the bottom of a shelf fastened to the front and sides of the tank.

A curved handle is mortised and glued into the steering post after the latter is in place. While the handle need not be shaped exactly as shown in Fig. 3, it should be long enough and high enough for the little driver to reach comfortably.

Headlights. Cut two disks and two rings, all of plywood 3″ in diameter. Paint the disks with aluminum paint and the rings black. When the paint is dry, glue a ring to each disk. Secure the headlights to the front of the tank with screws from inside the body.

Gun. A turning 17″ long, 1¾″ in diameter at the thick end and about 1″ at the thin end, makes a realistic gun. If the craftsman wishes to avoid a job of turning, he can use part of a tapered stair baluster or table leg, the butt end of an old billiard cue, or a small baseball bat. The gun shown was made from a toy bat that cost a nickel. A hole is drilled through the gun about 4″ from the thick end and it is mounted on a block by means of a large wood screw. The block is screwed to the inner side of the front of the tank and also to the uppermost steering-post shelf, as shown in one of the photographs.

Rapid-fire noise maker. A wooden ratchet noise maker of the type used at New Year's can be bought for a few cents, but it may be less trouble to make one to suit than to modify a purchased one. Cut a 1″ thick wooden ratchet wheel as shown in Fig. 4 and screw a flat handle to it. Then glue a thin hardwood "tongue," ⅛″ by 1″ by 7″, into a block. Fasten the block to one side of

the tank and mount the ratchet wheel to turn on a bolt. In order that the bolt may not work loose in the plywood, reinforce this part with a piece of ½" hardwood as shown in Fig. 4.

A turned handle spins freely on a long screw attached with one nut on each side of the flat crank. The handle may be recessed for one of these nuts. As the side of the tank acts as a sounding board, a very satisfying racket is produced.

Sprockets. There are ten sprockets of ¼" plywood, shaped as shown in Fig. 5. Several of them can be cut at one time by tacking the blanks together.

Three sprockets are nailed to the outside of each side; the remaining four are nailed to 2½" wide blocks on the inside. The position of these blocks is indicated by *E, F, G, H,* and *I,* in Fig. 2.

The rear axle must be sprung into place before the rear inner sprockets are nailed to the blocks. One of the photographs shows the forward end of the tank with one inside sprocket in place and the blocks mounted to take the other.

Treads. There are 44 treads, 36 of one kind and eight of another. The 36 are little blocks ¼" by ½" by 2½". These are nailed to the sides as shown in the photograph of the finished tank. The nails are clinched over inside. The small blocks must be drilled for them to prevent splitting. A simple jig clamped to the table of the drill press, as shown is another photograph, will speed the work. One hole is drilled with the block in the left corner of the jig and the second is drilled after it has been slid to the right.

Each of the larger treads consists of two pieces of wood nailed together. The dimensions are given in Fig. 6. These treads are nailed across the outer and inner sprockets as shown in one of the photographs.

Painting. For realism use paint that dries without gloss. The real tanks are not shiny. Two shades of olive drab are needed—the darker to make the sprockets and treads stand out a little from the flat sides. One way to get a serviceable olive drab is to mix green paint into a sandy tan until the proper shade is obtained. For the darker sprocket-and-tread shade, add more green or possibly a touch of black.

Disassemble the gun, noise maker, steering post, wheels, and so forth, and paint them all, as well as the body of the tank, with the olive drab paint. However, do not paint the tongue or wheel of the noise maker.

Next paint the sprockets and treads. Assemble the whole job after the paint is dry. A little touching up will probably be necessary to cover the nail heads on the sprockets and treads.

A final touch is the addition of lettering or numbers to the side of the tank in imitation of what on real tanks serves as military identification. The initials of the young tank driver might be used.

One method of painting the 36 small treads quickly is to put them into a can or other receptacle, pour a little paint over them, and stir with a stick until all surfaces are covered. Then drain off all surplus paint by tilting the can. Lay the treads on a piece of wire netting or tilt them up against pieces of scrap wood to dry. The sprockets and large treads are painted flat on a table, one side at a time.

ELECTROGALVANIZING [*ELECTRICAL*]

Zinc is a good, cheap plating metal for protection without a high polish. Equivalent plating requires half as much as does dipping in molten zinc.

Zinc is plated in either an acid or an alkaline (cyanide) solution. The former results in a brighter deposit, but it has less throwing power and is not suited for cast iron. A simple acid-type solution is made as follows:

Zinc chloride	1½ lbs.
Sodium chloride	2½ lbs.
Aluminum chloride	4 oz.
Water	1 gal.

This operates well at from 2 to 3 volts. To avoid uneven, spongy deposits, test occasionally with litmus paper to make certain that the solution remains on the acid side. The character of the deposit is finer if minute quantities of mercury chloride or nickel chloride are added by experiment.

Where the work is irregular, a cyanide electrolyte is more satisfactory because of its greater throwing power. Observe the usual precautions when handling and using the *extremely poisonous* cyanide solutions.

Sodium cyanide (POISON)	10 oz.
Zinc oxide	6 oz.
Caustic soda	2 oz.
Corn or grape sugar	2 oz.
Water	1 gal.

Dissolve the cyanide in the water warm it slightly (to 85-100 deg. F.) and add the zinc oxide; when this is dissolved, add the remaining chemicals.

Cast zinc anodes are preferable. For small operations, a zinc element sold for use in wet batteries is suitable.

POPULAR SCIENCE MONTHLY SHOP DATA

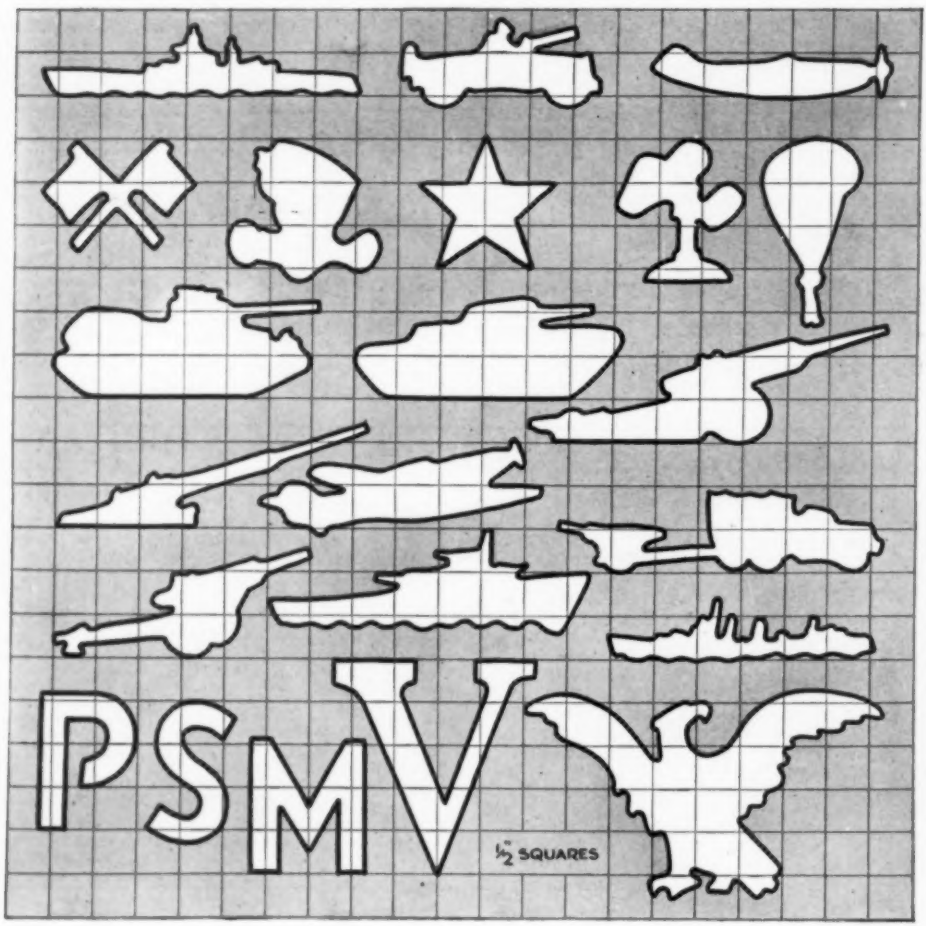
JIGSAW PUZZLES GO MILITARY

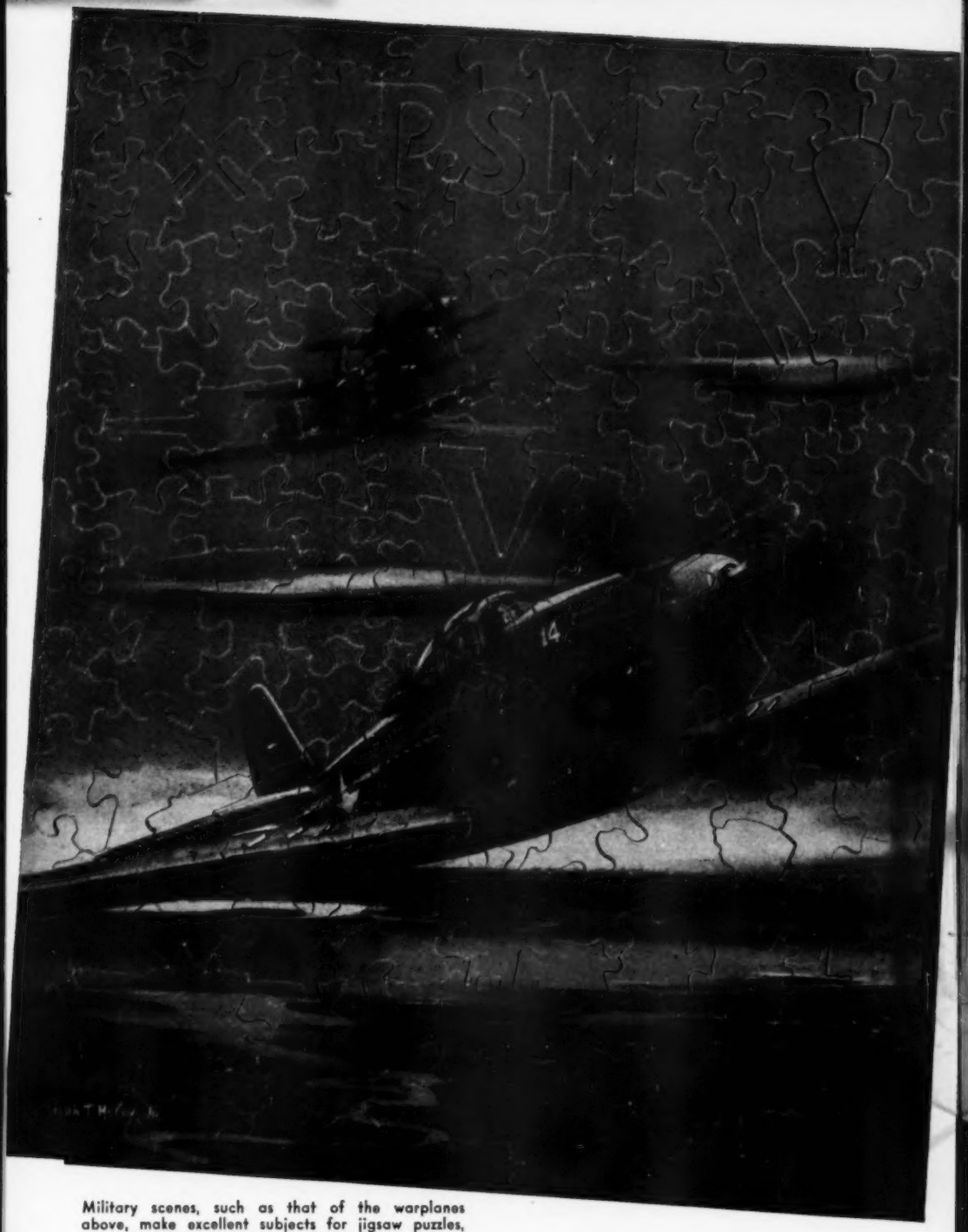
By W. L. FAUROT

WITH home amusements gaining in popularity, the ever-fascinating jigsaw puzzle is again winning favor. Such puzzles do not take much material, are fun to make, and entertaining to young and old. Furthermore, they can be put together by single puzzlers or by groups, for amusement only or in competition for prizes.

Modern jigsaw puzzles with a military motif make up-to-date, distinctive gifts. Pictorial subjects may include maps, magazine covers, photographs, calendar prints, and the like. By cutting some of the pieces in the shape of simple silhouettes of guns, airplanes, tanks, ships, and so forth, you give the puzzle greater interest and educational value. Children will enjoy identifying the pieces fully as much as putting together the puzzle.

By following the simple procedure to be described, even the beginner can turn out a good grade of jigsaw puzzle with a minimum





Military scenes, such as that of the warplanes above, make excellent subjects for jigsaw puzzles, and interest is added when simple silhouettes of kindred matter are used for some pieces—designs such as those on the facing page. It is also good practice to interlock at least the border pieces

When the picture is in place and the paste dry, trim off the edges of the panel with a sharp plane, working from the corners toward the center. Use a file on excess paper

of tools, labor, and expense, and without using hard-to-get materials. Very fine blades are not necessary to produce an interesting puzzle. Plenty of heavier blades are to be had and with these the craftsman can use ordinary ¼" plywood, which is more generally available than the bass plywoods once preferred.

The heavier material and coarser blade make for wider curves and larger interlocks than were formerly considered the mark of a good puzzle, thus simplifying the work for the beginner. That clean, sharp puzzles can be cut with comparatively coarse blades is evidenced by the one shown in the photograph. It was made with a blade having 13 teeth to the inch.

Select a clear piece of plywood slightly larger than the picture to allow for trimming and smoothing the edges. Prepare a size by soaking a small amount of flake carpenter's glue overnight in cold water. Pour off surplus water and bring the glue to a boil over a slow heat, taking care not to burn it. The flakes will liquefy. While the size is still warm, spread it evenly over the top surface of the plywood panel and allow it to dry. This size soaks into the wood and provides a good base for the paste.

Obtain a small quantity of cold-water paste powder such as is sold at hardware stores, paint stores, and paper-hanging supply houses. Mix in cold water to a creamy consistency; then add about 10 percent liquid glue and mix thoroughly.

Prepare the picture by moistening it with a sponge or cloth on both back and front so that the paper will expand to its limit before the paste is applied. This also eliminates wrinkles and bubbles. If not thus moistened, the paper will have a tendency to curl and pull away from the panel at the edges as it dries.

Next, using a large brush, apply paste generously to the sized side of the panel. Brush it in vigorously, first across the grain, then with the grain. Apply plenty of paste, for any surplus will squeeze out at the edges as the picture is rolled down.

Apply a thin, even coat of paste to the back of the picture. Lay the picture carefully upon the paste-coated panel. Keep a wet cloth handy to clean up surplus paste. Cover the panel with a clean sheet of wrapping paper and on top place a few layers of newspaper. Roll carefully, first from the center to the edges, then in all directions, with an old photographic print roller. If none is available, use a rolling pin or even a bottle. This rolling should squeeze out all air and surplus paste from between the paper and the panel and press them into perfect contact.

Be careful never to place newspaper directly against the damp face of the picture, as the print will transfer and be hard to remove.

After rolling, clean all traces of paste from the picture face and the edges of the panel. Examine the surface for bubbles, wrinkles, and other poor contact, especially at the edges. If, in spite of all precautions, wrinkles do appear, pull the picture off and start over again.

When satisfied that all excess paste has been removed, lay the panel face up on a solid, flat, smooth surface. Cover with a layer of thin waxed paper such as that used for wrapping sandwiches. Pad this with a ½" thick layer of flattened newspapers. Place another plywood panel on top and weight all with magazines, books, or other heavy articles. A lot of weight will prevent warping. Leave under weight for 24 hours. If insufficient weight is applied or too little time is allowed for drying, the picture will, as it shrinks, pull the panel into a curve. It will then not lie flat upon the saw table, and the result will be a generally unsatisfactory job.

After drying, the panel edges may be trimmed. Hold the panel on a bench or table top with a little extending over the edge. Trim the edges smooth with a razor-sharp plane, working from the corners toward the center to avoid splintering. A few

Final sanding of the back removes small fibers torn loose by sawing. Turn the assembled puzzle over on a flat panel and hold it together with battens. Sand with the grain

strokes across the edge from the face toward the back with a coarse, sharp file will shear any remaining paper edge cleanly away. A piece of fine sandpaper folded around a wood block will finish the edges nicely.

Trace the figure patterns on thin paper ruled off into ½" squares by following the outlines from point to point on the smaller squares in the drawing. Coat the back of the paper with rubber cement, and also the surface of the picture where the designs are to be placed. When the cement has dried, apply the designs and smooth them down. After sawing, the paper will peel off easily and the remaining cement can be rubbed off with a finger tip or a soft eraser. If the maker prefers, he can cut out cardboard patterns and simply draw the designs with them on the picture.

Saw with the picture side up and the teeth of the blade down so that splintered edges will be on the underside. Big puzzles can be cut in two for easier handling, but be sure to saw a good key on this bisecting cut, as well as on all other border pieces. When making cuts parallel to the edge, keep them inside of these first keys. This applies to all cuts leading in from the edge.

As the pieces are sawed, assemble them on a tray or a piece of plywood. When all are cut out, lay another flat piece on top and turn all over together. Remove the top panel and brad small strips of wood around the outer edges of the puzzle. These battens must be thinner than the puzzle stock. Push together the sawed pieces, holding them with the strips so that the back may be sanded smooth. Sand with the grain to remove all the small fibers torn loose by the saw. Finish with fine sandpaper. Do not round off the edges. Shake or blow all dust away, turn over, inspect for loose paper edges, and paste them down.

FINISHING LEATHER ARTICLES [*LEATHER CRAFT*]

Finish laced edges of leather articles by placing the laced edge on a smooth surface. Tap the lacing lightly with a smooth hammer. Clean and polish natural and dyed leather with saddle soap. Apply a thin coat with a soft damp cloth and rub the surface lightly. Let it dry a few minutes; then polish with clean, soft cloth or use the palm of the hand. Work all new leather well between the hands to make it soft and pliable. To produce a high luster, a commercial polishing solution may be applied and the article polished according to directions. Too much wax, however, will cause the leather to become hard and crack.

Recondition used leather articles by cleaning them several times a year or as often as needed. Clean them with saddle soap or some mild white soap. White shoes, if made from a good grade of leather, may be cleaned with saddle soap and then a high grade of white shoe polish, applied according to directions. Slide fasteners on leather articles may be made to move easier if a drop of light oil is applied to the slide. Too much oil will cause the tape to deteriorate. Worn lacing should be replaced immediately with new to prevent excessive wear to the edges of the leather.

POPULAR SCIENCE MONTHLY SHOP DATA

Silver Chest

By JOSEPH ARONSON

THIS simple chest, which derives from the Colonial but will be equally harmonious with modern or Colonial furnishings, is a project well within the scope of the amateur cabinetmaker. It was planned as an accessory piece for a small dining room to hold silver both flat and tall, but it will just as well serve as a console chest in a hall, a record cabinet in the living room, a buffet server, or the like.

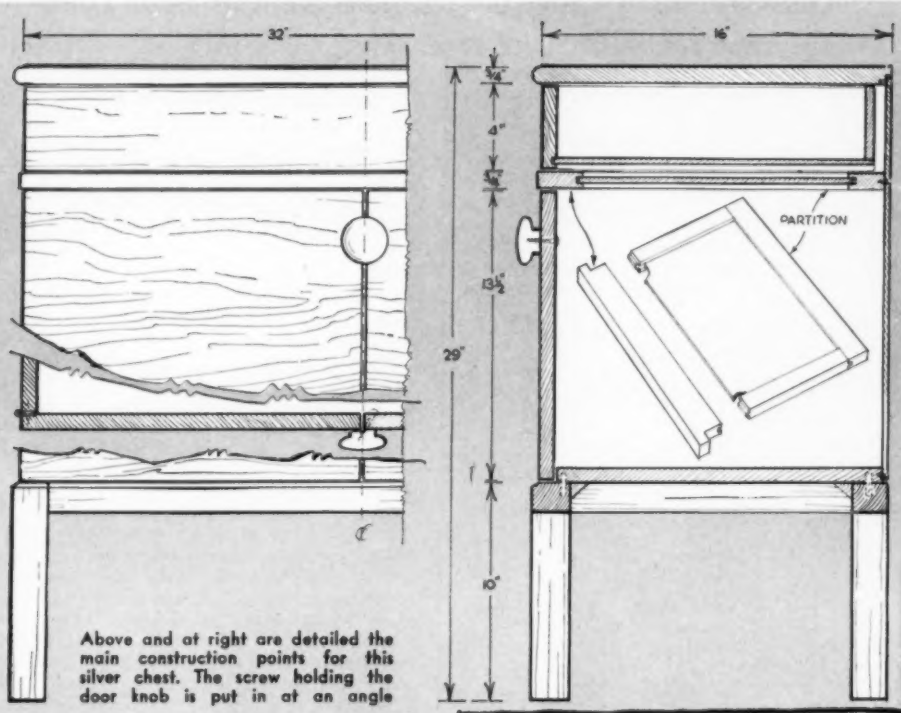
The choice of woods will determine the character of this piece. Walnut or mahogany will produce a refined and conventional effect, especially if the grains are nicely selected. Oak will give the chest a heavier quality, while pine or fir yield a feeling of country simplicity. Since each craftsman will have a specific room in mind, he will probably choose the wood on the basis of the chest's ultimate place and purpose. The neutral solution, of course, would be a painted finish, and this is also a safe choice for the less confident craftsman.

The body of the chest is a simple box structure of plywood panels with a frame separating the drawer compartment from the larger one below. This frame projects ⅛" in front, producing a banded effect which is carried around the sides by gluing ⅛" by ¾" strips to the side panels. The top is molded, or a molded effect is obtained by mitering around the edges of the plywood top a ⅝" half-round molding. A ¾" plywood panel is doweled to the sides to form the floor. Both this and the partition are made ¼" short in back to allow for the back panel, while the sides and top are rabbeted ¼" by ½" to receive this panel.

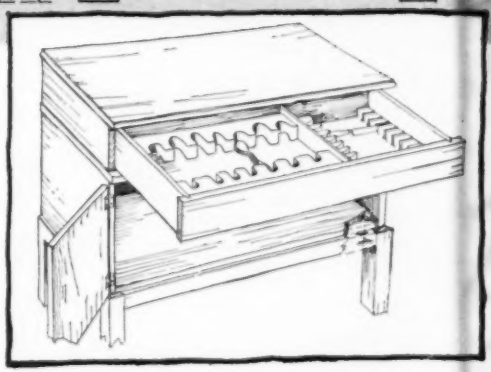
The design is definitely improved by using the grain of all the wood in the chest section horizontally, and so far as possible cutting the doors and sides out of continuous grain; certainly the two doors should be cut out of one piece. As the doors are hinged on the side, the exposed ends show cross grain. It would be desirable to veneer this edge of each door with a strip from waste plywood.

Assemble the base framework separately and attach it to the chest with screws, or dowel and glue the two units together.

Suggestions for a drawer arrangement for flat silver appear in the accompanying drawings. Knives must be stored individually, but spoons, forks, and butter knives can



Above and at right are detailed the main construction points for this silver chest. The screw holding the door knob is put in at an angle



be kept in groups. In the knife compartment, fit a series of small blocks separated by the thickness of a knife handle, and another row opposite, spaced to receive the blades. Paste felt on the drawer bottom; then cover the exposed sides of the blocks also. Attach them with screws from beneath.

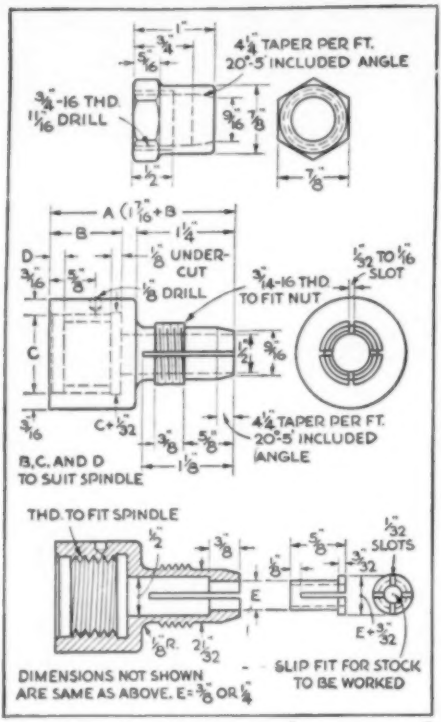
Arrange all the spoons, forks, and other pieces in stacks in the remaining drawer space. Draw around them and transfer the resulting pattern to a thick block of pine or balsa wood. Band-saw two pieces—one for the handles and one for the bowl ends.

LIST OF MATERIALS

No. Pc.	Description	T.	W.	L.
1	Top (plywood)	¾	16	32
1	Half-round molding	⅝		63
1	Floor (plywood)	¾	15	30½
2	Sides "	¾	15¼	18¼
1	Partition front (solid)	¾	2	32
1	" back "	¾	2	30½
2	" sides "	¾	2	12⅜
1	" panel (ply.)	¼	12⅜	27½
1	Back panel (plywood)	¼	18½	31
1	Drawer front (ply.)	¾	4	32
1	" bottom "	¼	15	29¾
2	" sides (solid)	½	4	15
1	" back "	½	3⅜	30½
4	Legs	1¾	1¾	10
2	Stretchers	1⅜	1¾	29¼
2	Rails	1¼	1⅜	12⅞
2	Band molding	⅛	¾	16⅛
2	Doors (plywood)	¾	13½	16

Note: All dimensions are given in inches.

Outside-Closing Collet Chucks Hold Work in Small Lathe



These adapters, turned from tool steel, take work up to full diameter of the hole through the spindle

THESE outside-closing collet chucks will take work up to the full diameter of the hole through the lathe spindle. They should be turned from tool steel so that they can be hardened and tempered, although, if necessary, they may be used unhardened. The accompanying drawings show typical collets for ¼", ⅜", and ½" stock, but any size can be made up to the spindle bore.

Bore, recess, and thread the shank exactly like the small faceplate of the lathe. Then screw the piece on the spindle nose, turn the outside, cut the threads for the closing nut, and drill the hole for the work slightly undersize. This hole should be finished with the utmost accuracy. If the collet is to be hardened, the hole should be brought to finish size afterwards with a tool-post grinder. The slots are, of course, cut before the piece is hardened—either by hand or with a thin metal-slitting saw of small diameter.

File or mill two flats on the shank end for a wrench to fit over, or drill a ⅛" hole as shown for insertion of a spanner to aid in unscrewing the collet from the spindle.

The clamping nut is turned from the same steel stock with an internal taper corresponding to that on the collet chuck. Adapter bushings for in-between sizes of work are turned outside to fit the collet, then inserted and drilled through, and finally slotted. The work must never be smaller than a slip fit in the collet or adapter. Never close the clamping nut without work in the hole.—G. S. LAWRENCE.

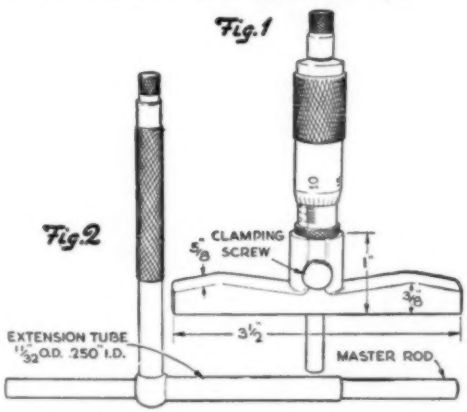
Micrometer Head and Anvil Form an Accurate Depth Gauge

Two ways to increase the scope of precision measuring instruments so that one will do the work of several are illustrated. Figure 1 shows how a standard micrometer head was fitted with an anvil to make it a highly accurate depth gauge. The anvil was machined from cold-rolled steel, casehardened, and chromium plated. It has a .500" hole to fit the clamping diameter of the caliper head, and is secured by a knurled screw. The foot surface was ground from an arbor and lapped true.

To increase the measuring range both of this depth gauge and of standard telescoping gauges (Fig. 2), a piece of 11/32" tubing of exactly .250" inside diameter is slipped over the spindle or plunger. Master rods 1", 2", or 3" long can then be slipped into the tube against the square end of the inside member to extend the measuring range. Be sure all parts are clean when assembling them.—FRANK J. SCHMITT.

Fig. 1

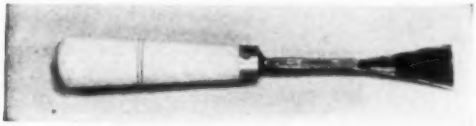
Fig. 2



With priorities making it necessary for a single tool to do the work of several, these drawings show how standard gauges may be stepped up in range

Question Bee

CHISELS date from earliest antiquity when men first began carving on stone. Today they are used in almost as many shapes and sizes as there are jobs to do, and are indispensable tools of workers engaged in industry and art. Some chisels are flat, others hollowed or saucered; their points and weights vary according to their intended use; some handles are socketed, others tanged, and some chisels have no wooden handles at all. There are percussion chisels, always used with a mallet, and there are pressure chisels used without a mallet and depending entirely upon hand pressure. The photographs below show a selection of ten chisels used commonly by machinists, carpenters, or wood carvers. How many of them can you name correctly? Study the pictures, write your answers, and turn the page upside down to check them.



1.....

2.....

3.....

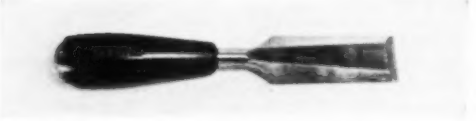
4.....

5.....

6.....

7.....

8.....



9.....

10.....

ANSWERS

1. Wood carver's fishtail chisel.
2. Cold chisel—regular (used by machinists and others).
3. Gouge.
4. Machinist's diamond-point chisel.
5. Bevel-edge socket chisel
6. Machinist's round-nose chisel.
7. Wood carver's parting chisel.
8. Machinist's cape chisel.
9. Butt chisel.
10. Wood-ripping chisel

Using the spindle shaper for freehand molding on a bench leg. A pointed stick clamped to the table serves as a starting pin to guide the first cut

Curved Work ON THE Spindle Shaper

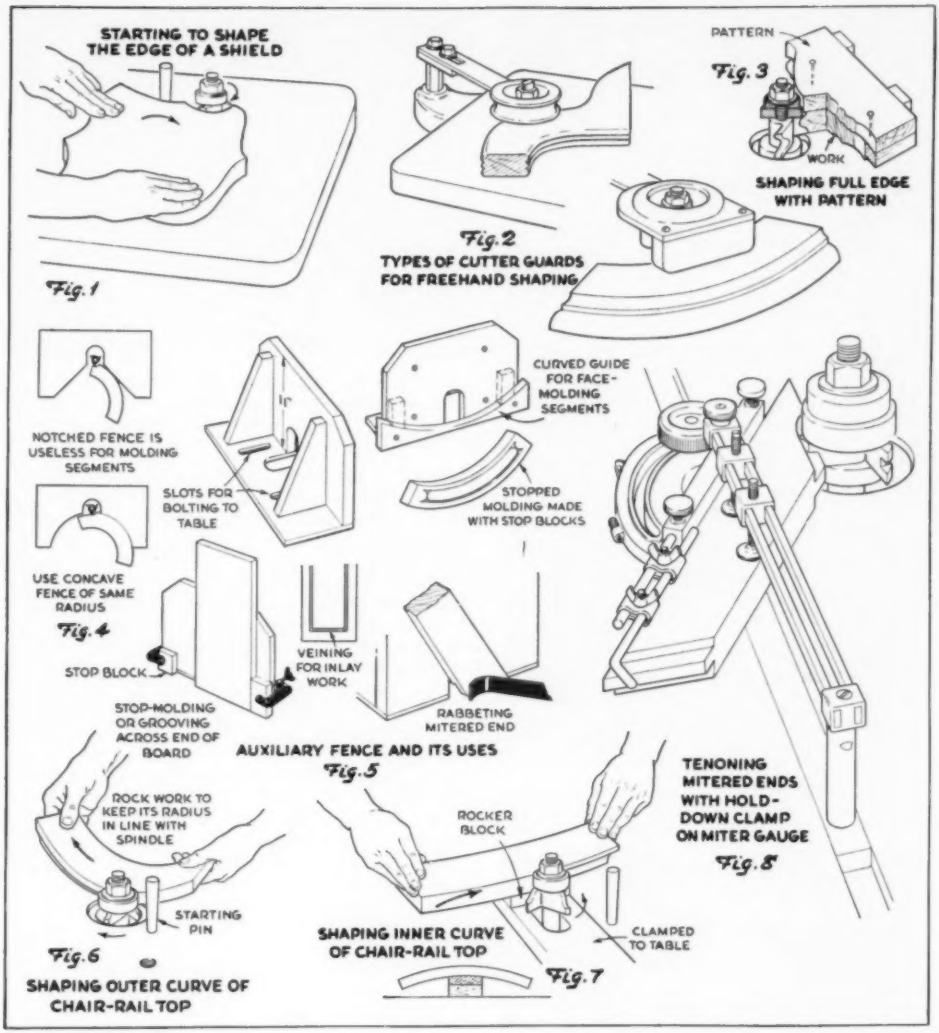
By
EDWIN M. LOVE

CURVED work done on the spindle shaper really demonstrates the full scope of that versatile machine's decorative possibilities, putting within reach of the home craftsman the professional touches usually associated with the fine woodwork in studios and showrooms. There are but a few rules to be followed in turning out excellent freehand pieces. Most of them concern setting up the work, precautions for safety, and the use of fences, patterns, and jigs; otherwise the procedure is much the same as for straight work.

How is a shaper set up for freehand work? Select the desired cutter and mount it on the spindle with the cutting edges facing in the direction of rotation, as in straight work. The depth collar used as a gauge in shaping curved work is usually placed below or above, or sandwiched between two cutters when it is desired to make moldings on both corners of an edge at once. Obviously collars larger than the cutter used below or above must be placed where they will not touch the work. One part of the edge must remain uncut for the guiding collar to rub against. Any attempt to shape the entire edge freehand is likely to result in ruined work and perhaps injured fingers. Always test the setup by making a trial cut on waste wood.

What is the way to prepare work for freehand shaping? Band-saw or otherwise cut it to profile and finish the edge smooth. The shaper will follow exactly all irregularities in the guiding edge, and reproduce them in the molding, so the edge must be true and smooth. Examine the depth collar for rust, because a coating of rust cuts like emery and will destroy the guiding edge. Also remove any accumulation of resin by scrubbing the collar with a wire brush and cleaning fluid.

How is freehand work started? If the shaper has a starting pin, insert it in a hole ahead of the cutter, pivot the work against it, and swing the piece slowly into the rotating cutter, preferably where it will cut with the grain, as in Fig. 1. A pointed block, clamped to the table as in the photograph at the top of this page, may be used instead of a pin. When starting at the end of the work, slide it toward the cutter in the path it will take. After starting, move away from the pin and guide the work on the depth collar alone, advancing the piece against rotation. Never feed work with the cutter, that is, in the direction of rotation, for the knives will snatch the stock from the hands, and the fingers may be drawn into the cutter.


STARTING TO SHAPE THE EDGE OF A SHIELD
Fig. 1
Fig. 2
TYPES OF CUTTER GUARDS FOR FREEHAND SHAPING
PATTERN
Fig. 3
WORK
SHAPING FULL EDGE WITH PATTERN
NOTCHED FENCE IS USELESS FOR MOLDING SEGMENTS
USE CONCAVE FENCE OF SAME RADIUS
Fig. 4
SLOTS FOR BOLTING TO TABLE
CURVED GUIDE FOR FACE-MOLDING SEGMENTS
STOPPED MOLDING MADE WITH STOP BLOCKS
STOP BLOCK
VEINING FOR INLAY WORK
STOP-MOLDING OR GROOVING ACROSS END OF BOARD
RABBETING MITERED END
AUXILIARY FENCE AND ITS USES
Fig. 5
TENONING MITERED ENDS WITH HOLD-DOWN CLAMP ON MITER GAUGE
Fig. 8
ROCK WORK TO KEEP ITS RADIUS IN LINE WITH SPINDLE
STARTING PIN
Fig. 6
SHAPING OUTER CURVE OF CHAIR-RAIL TOP
ROCKER BLOCK
CLAMPED TO TABLE
SHAPING INNER CURVE OF CHAIR-RAIL TOP
Fig. 7

Can the cutter be guarded in freehand work? Figure 2 shows two types of guards used on some machines. Always exercise care with a shaper; it is a safe machine if proper attention is directed to the task of the moment. Never try to shape small pieces in the hands; use some kind of jig.

Does inside shaping require special setups? Shaping of cut-out sections is much like outside work. Drop the piece over the cutter, start the machine, and feed slowly against the knives. With small holes it is, of course, difficult to use a starting pin.

Is there a way to shape the entire edge of the stock? Pattern shaping is the solution to this. Cut out a template, say from 1" stock, finishing the edge smoothly. If a depth collar of the diameter of the smallest part of the cutter is available, make the pattern the same size as the finished piece; otherwise it must be larger or smaller in accordance with the diameter of the depth collar used. Drive two or more screws or nails through the pattern and sharpen the points, or use flat prongs like glazier's points set with the grain. Press these into the work and handle the assembly like a solid piece, with the pattern above or below and the

Shaping the inside of a ring with the assistance of a notched board used as a fence. A concave or convex fence is substituted for molding segments

Cutting beads on the face of a segment with the help of an auxiliary fence and a curved guide. The high front of this type fence can also be used to support the face of a wide or long board

Trimming a rough-cut disk and molding it. This is accomplished in one operation with the aid of a pivot jig. The disk is turned on a metal point

depth collar following the pattern edge, which should be waxed or soaped to reduce friction. Ball-bearing collars that roll along the guiding edge are available. These prevent scoring.

Pattern shaping is excellent for making duplicate parts. Cut a stack of blanks roughly in a box jig with the band saw, and use the pattern for truing and molding the edges of one at a time, as in Fig. 3.

Can special fences be used? A notched board bolted to the table, as shown in one of the photographs, is satisfactory for shaping the inside as well as the outside of circular work. The stock is pressed into the notch and slid past the cutter. No guiding collar is used. However, this type of fence is not suitable for segments, as the ends of the work would receive no support. Instead, a fence curved to the same radius is substituted, concave for molding convex curves, convex for shaping concave ones, as in Fig. 4. An auxiliary fence constructed as shown in Fig. 5 is useful for several operations. The high front gives support for face shaping on wide or long boards, and for face work on segments, as shown in one of the photographs.

What is a pivot jig? This is illustrated in another photograph. A metal point or a dowel pin is set in a baseboard, which is clamped to the shaper table with the spindle projecting through a hole. The blank, cut roughly to shape, is forced on the point; the jig is pushed forward until cutting depth is reached, and then clamped in position. Rotating the blank against the cutter shapes it to a circle.

How are compound curves shaped? Lay the convex side of the work on the table and feed it past the cutter, rocking it to keep it at right angles with the spindle at the cutting point (Fig. 6). If the work is bowed but in a plane, a fence is useful. Mold the

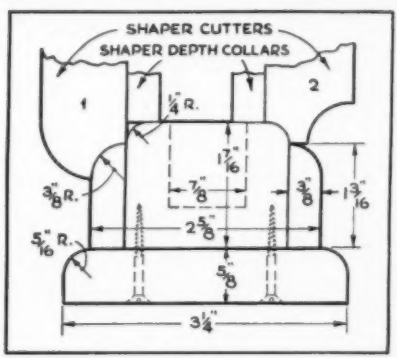
Using a miter gauge, obscured here by the fence, for tenoning the end of a bench leg. The clamp keeps the work from creeping away from the cutter

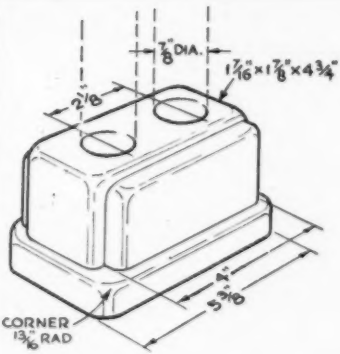
Drum sanding on the shaper. For this the speed must be reduced to about 2,000 r.p.m. to prevent glazing the sandpaper and causing work to "burn"

hollow side by sliding it over a crowned block clamped to the table, as in Fig. 7. It is usually necessary to raise the cutter extremely high so that the ends of the work will clear the table.

Has the shaper any other uses? Drum sanding is easily done if the speed is reduced to about 2,000 r.p.m. to prevent burning the wood and glazing the sandpaper. The sandpaper sleeve should be put on so that the lap follows rotation, to prevent it from peeling back.

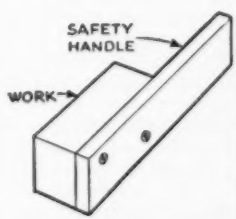
How is a miter gauge used with the shaper? Clamping arrangements are usually necessary to prevent creeping of the work. This is one means of performing multiple shaping, and the ends of pieces can be molded, grooved, rabbeted, and tenoned (Fig. 8).

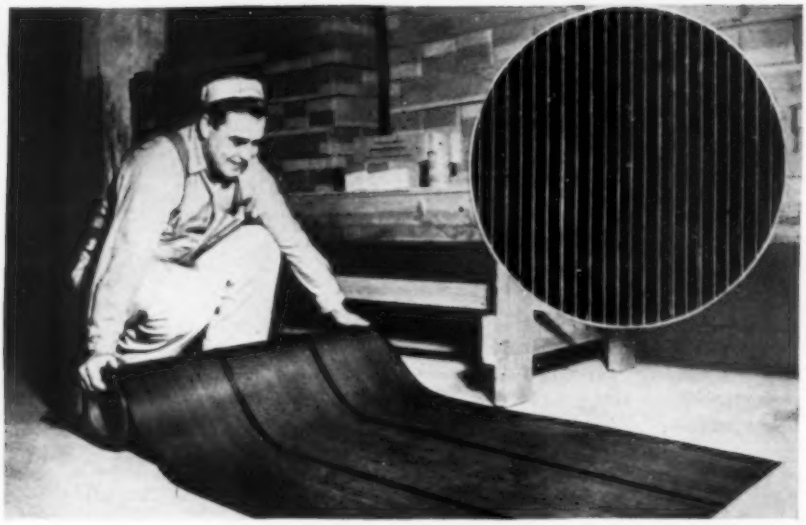




Modernistic Candlestick with Double Shaping Cuts

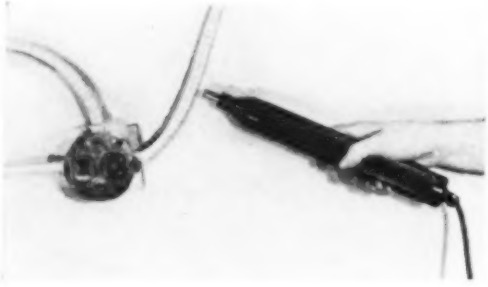
Making this attractive piece will give the craftsman plenty of practice in double shaping cuts, as the accuracy of the quarter-rounds depends on careful adjustment of the cutters. The moldings can be made with standard knives. Use two hardwood blocks, preferably ripped from one piece of stock, for matching grain. Cut to size and smooth the upper block, shaping it freehand with a strip of wood screwed to the underside for a safety handle. Cut the outer or step molding first, then the other. Shape the base and screw it to the upper block. Bore holes for the candles, stain, and varnish.





IDEAS for HOME OWNERS

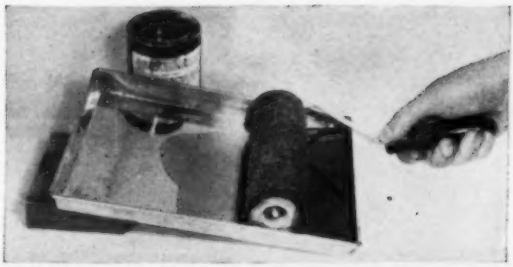
CORRUGATED FLOOR RUNNERS are being made of an asphalt composition to take the place of rubber in hallways, basements, and other places where a nonskid, waterproof covering is desired. Mats for smaller areas and treads for stairways are also available. Runners come 36″ wide in lengths of 30′, mats are from 2′ by 3′ to 3′ by 6′, and treads are in two sizes, 9″ by 18″ and 9″ by 24″.



ELEVEN SCRAPING BLADES on the new type wood scraper shown below do the work of paint and wood scraping many times faster than the old one-blade tool and save time on much of the work on which sandpaper, steel wool, files, and wire brushes are used. This new scraper removes calcimine with great speed, and may be used on rough, painted, enameled, varnished, or shellacked surfaces.

HIDDEN WIRING CAN BE TRACED under floors and behind plaster, wood, thin tile, or concrete walls or partitions with a new high-frequency detector that aids electricians in finding forgotten circuits and plastered-over junction boxes. The detector plugs into any standard 110-volt A.C. socket. When it is held over a concealed outlet, conduit, armored cable, or any other metal fixture, violet high-tension sparks issue from a metal electrode at its tip, revealing both the location and the shape of the hidden object.

A PAINTBRUSH WITHOUT BRISTLES, this roller has been developed for covering walls, ceilings, and other large surfaces, and is especially adapted for use with cold-water paints. The color is mixed as desired and a little poured into a cake pan or other flat, square container the width of the roller. The roller is dipped in it and then applied to the wall. Margins are finished with a brush. The roller is easily cleaned with water.

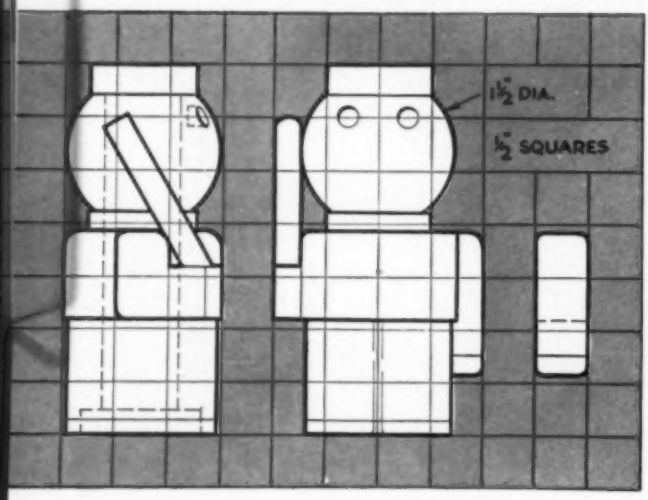


BLACKOUT ACCESSORIES FOR THE HOME

PLASTIC TRACKS FOR WINDOW EDGES offer a solution to the problem of eliminating cracks of light at the edges of blackout curtains. The strips are installed permanently on both sides of each window, and permit easy raising and lowering of a curtain while holding it flat against the window frame. They are finished in either black or white, have a high, natural luster that needs no polishing, and in many cases form an attractive edging for the window frame.

FLAMEPROOFING DRAPERY, upholstered furniture, and clothing is done with the aid of a new chemical that can be sprayed onto the fabric from an ordinary garden sprayer. The chemical is marketed as a powder and is dissolved in warm water for use. It is effective on any type of cloth fabric or paper. The material treated will char, but will not burst into flame. Small articles of clothing, such as children's dresses and the like, may be rinsed in the solution. The chemical withstands dry cleaning, but must be renewed after laundering.

A somewhat oversize photo of Salty Sam; he's actually only 3½" tall. His tanned face and hands are natural mahogany



Salty Sam

A NOVEL SALT AND PEPPER SET DESIGNED BY JUAN OLIVER

FOR the craftsman in wood who aspires to some very simple figure work, here is a salt shaker in naval style—a sailorman. The example shown was made of mahogany, and the head was finished a natural wood color with shellac only.

Mount a 1½" by 1½" by 3¾" turning square between lathe centers and turn the head, cap and neck. The ¾" hole through the body can be bored on the lathe or the drill press, but first bore the recess about ¼" deep with a 1⅛" bit.

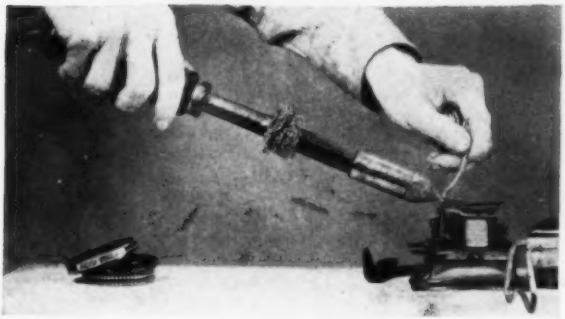
From the shoulders down the figure is square, with slight rounding of the corners and edges. Legs are indicated by a tiny V-cut in the middle, fore and aft. The arms are cut separately and glued on, with a short piece of ¼" dowel for the gun, which is painted black. Bore shallow holes for the eyes, and 12 or more 1/16" holes evenly spaced in the cap. Finish with lacquer, japan colors, or enamel. Fit the smaller bore with a cork.

For a companion pepper shaker, duplicate the construction, but drill 3/64" holes in the cap. If desired, the pepper shaker can be painted navy blue instead of white.

• • •

DON'T discard the bucket in which house paint comes until you have scraped out the small quantity of paint remaining. Drained of extra oil and thickened with whiting, these paint remnants make an excellent putty. Since putty is almost always painted, the color of the left-over paint does not usually matter.—T. L.

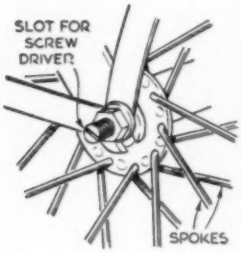
Copper Gauze Keeps Handle of Soldering Iron Cool



SOME modern electric soldering irons have fins that dissipate the heat and prevent the handle from getting uncomfortably hot. If yours is not so equipped, you can keep the handle cool by wrapping copper gauze from an old kitchen scouring pad around the shank as shown in the accompanying photograph. Fasten it in place with wire. If one does not give enough of a cooling effect, use two.—W. C. WILHITE.

Slotting End of Bicycle Axle Aids in Tightening Nut

WHILE fixing my bicycle recently, it was necessary to hold the axle rigid so that I could tighten the nut that keeps the axle in the frame. I found that by slotting the end of the axle with a hack saw, I could easily hold it stationary with a screw driver while tightening the axle nut with a wrench in the usual way. Do not saw a deep slot. Only enough to give the screw driver a fair hold is needed.—R. B.



Knife for Mounting Snapshots Made from Steel Pen

A HANDY knife for making double cuts in album pages to receive the corners of photographic prints can be made by inserting a steel pen nib, point first, in a penholder and sharpening both edges. Use the print to locate the cuts.—OLIVER BANDELIER

TYPES OF SOCKETS TO USE [*ELECTRICAL*]

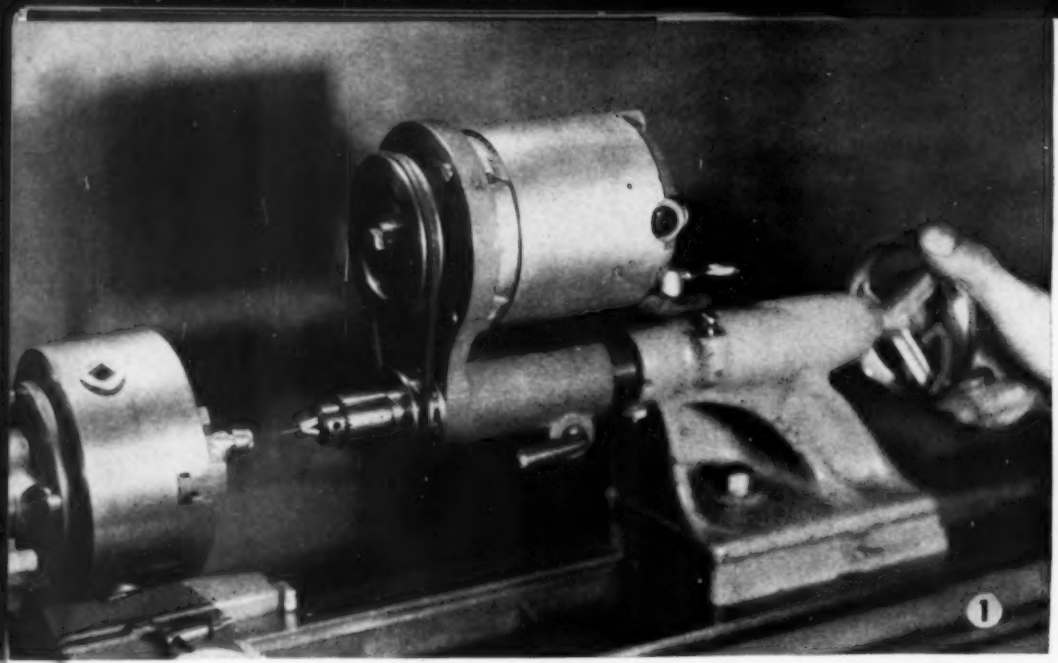
The choice of an electrical socket or receptacle should be governed by its intended purpose and by the location in which it is to be installed. Where the floor is often damp or wet, or of a conducting substance such as soil or metal, porcelain or composition sockets are required to lessen the likelihood of shocks. If an ordinary pull-chain socket is used, an insulating link should be inserted in the chain. Make sure that the grounded wire goes under the silvered screw, which is the terminal of the socket's screw shell.

If lamps of high wattage are to be used, the sockets should be porcelain, for extreme heat will cause the fiber lining of brass sockets to deteriorate.

Push-switch sockets are suitable for small boudoir lamps and the like, as they eliminate the danger of pulling the lamp over when turning it on—a possibility always present if a pull switch is used.

Sockets on drop and extension cords should preferably be of porcelain or composition. If brass sockets are used, the caps should have insulating bushings where the cord is taken out.

POPULAR SCIENCE MONTHLY SHOP DATA



High Speed Drill

BUILT TO FIT LATHE TAILSTOCK

By C. W. WOODSON

SHOPS engaged in making certain types of small parts for war production will find this high-speed lathe tailstock drill a timesaving attachment. If castings cannot be obtained, it might be constructed from steel plate and shafting, welded together.

The ball-bearing motor and spindle (Fig. 1) make it possible to run very small drills at the high speed necessary for free cutting, which few drill presses will attain—a No. 80 drill, for example, must run at over 30,000 r.p.m. to reach the recommended speed of 110 feet per minute in drilling soft steel. The lathe chuck affords a convenient means of holding work, and the indexing head may be used for spacing radial holes if the tailstock is set over as necessary.

The wooden pattern (Fig. 2) is glued up of jigsawed and turned parts. Core prints are added to the spindle housing so that the bore through this part can be cored-in at the foundry. This lightens the casting, gives a better section of metal, and saves considerable drilling and boring.

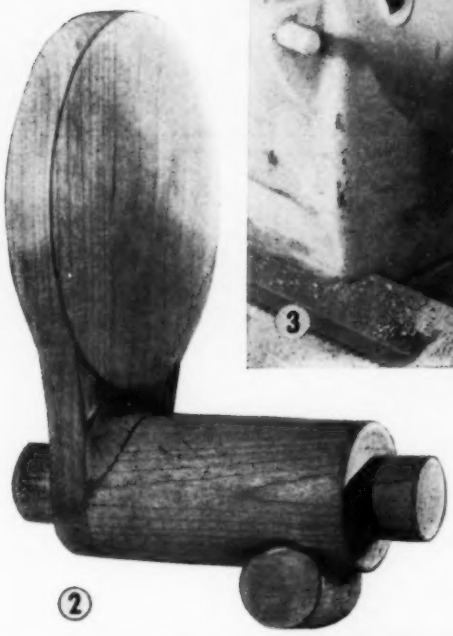
The gray-iron casting, after being cleaned of all traces of foundry sand, was chucked as in Fig. 3 and a facing cut was taken on the outboard end of the motor bracket with a heavy cemented-carbide tool. The hole for the motor shaft and bearing housing was then bored (Fig. 4) at the same chucking.

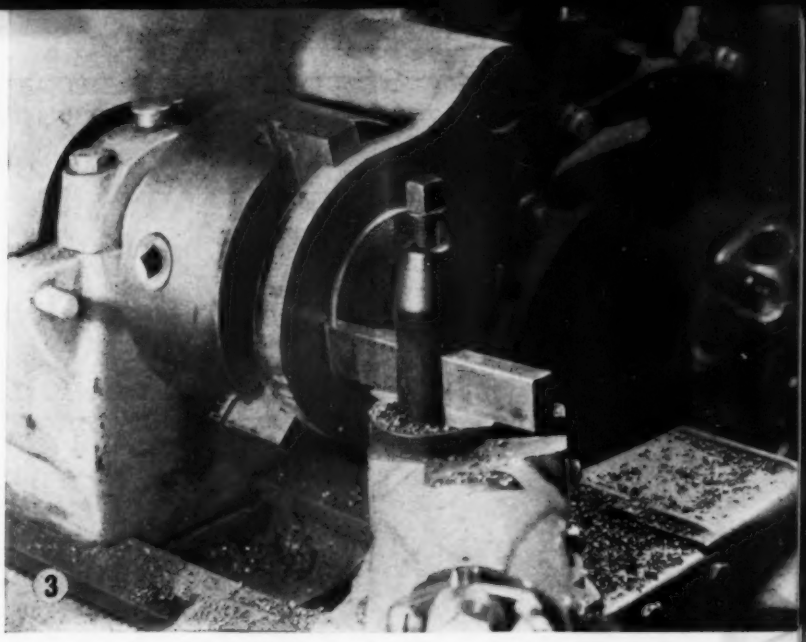
Facing the inside of the motor bracket was a little more difficult because of the projection of the spindle housing; this, however, was accomplished with an over-hanging boring bar as in Fig. 5.

An improvised setup was used in boring the spindle hole. This consisted of a fly cutter turning between centers and a drill-press vise fastened to the cross slide, in which the work was clamped, as shown in Fig. 6. By carefully adjusting the cutter and taking a number of light cuts, a perfect fit for the bearings was obtained. The outer race of a ball bearing served as a plug gauge. The tailstock spindle was similarly used in boring the smaller diameter.

Oil holes were drilled for the bearings, and the $\frac{1}{4}$" hole for the clamp screw, which locks the attachment on the tailstock spindle, was then drilled with the work held in the vise. The slot in the clamping lug was cut with a hack saw. One half of the hole was then opened out to 5/16" and the other half tapped 5/16"-18 to receive the screw.

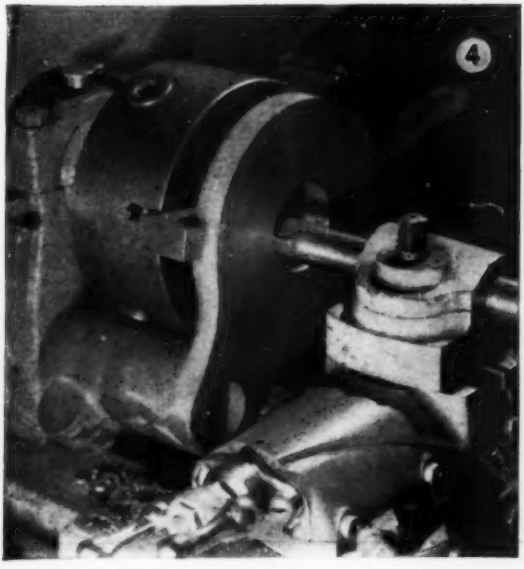
The high-speed motor used is of the universal, ball-bearing type, similar to some vacuum-cleaner motors. Holes for mount-

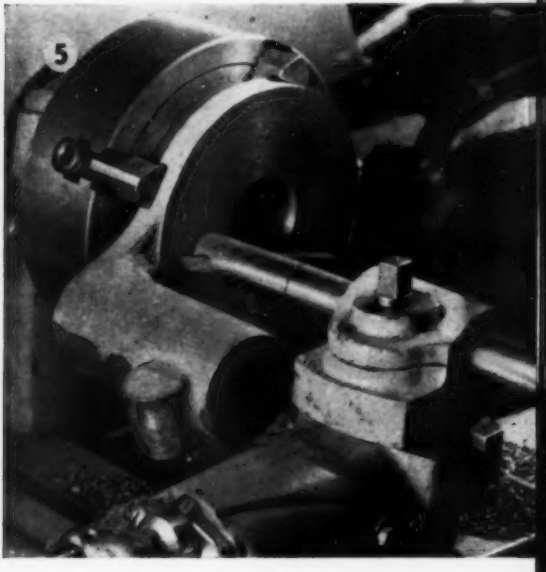


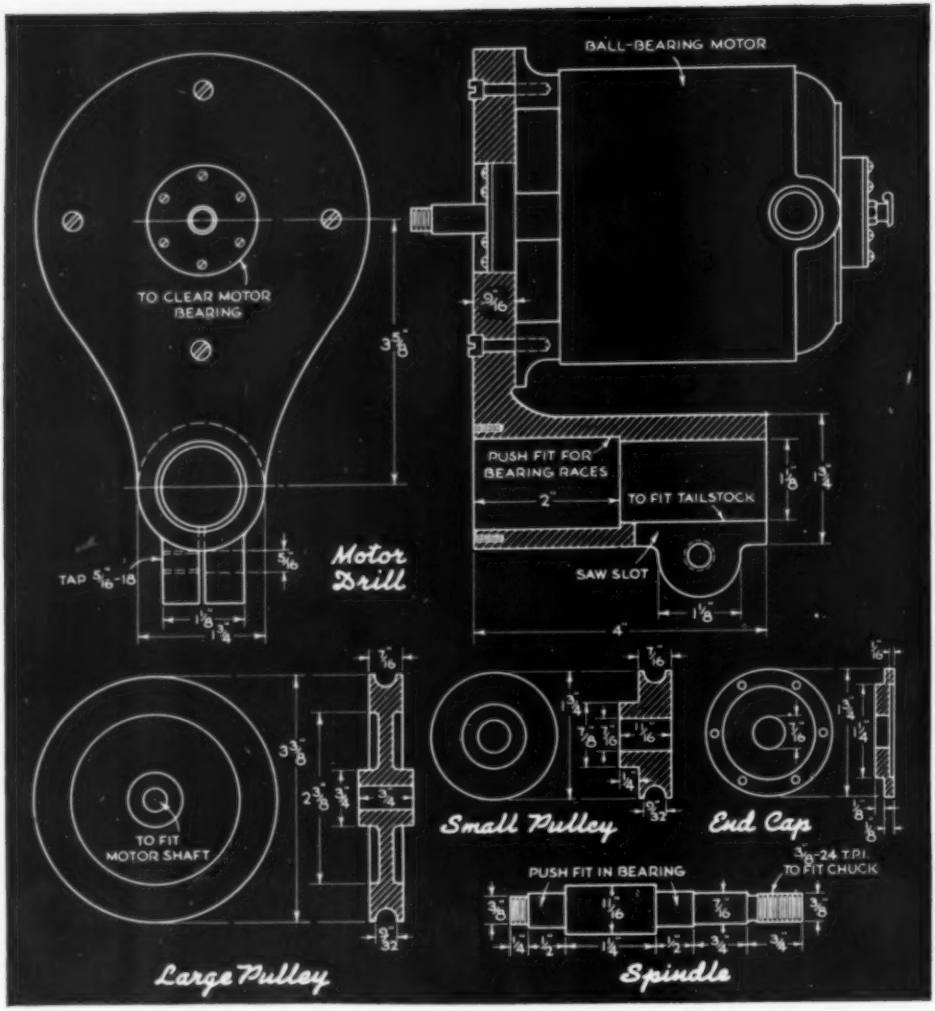


At left, the assembled wood pattern, which is glued up of jigsawed and turned parts. Note the core prints added to the spindle housing so that the bore through this part can be cored-in at the foundry. Above, how the facing cut is made on the outer end of the casting

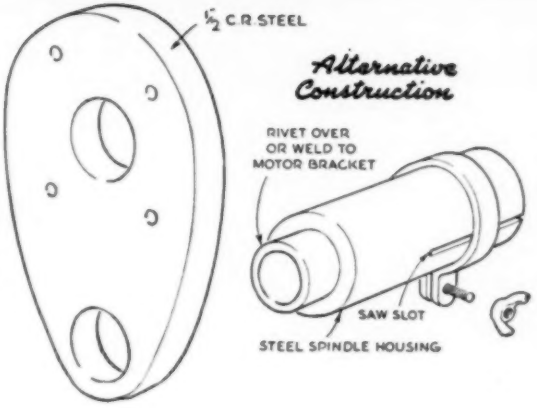
At the same chucking, the hole for the motor shaft and bearing housing is bored as shown at the left below. Because of the projection of the spindle housing, it is harder to face the inside of the bracket, but it is done (below, at right) with an overhanging boring bar

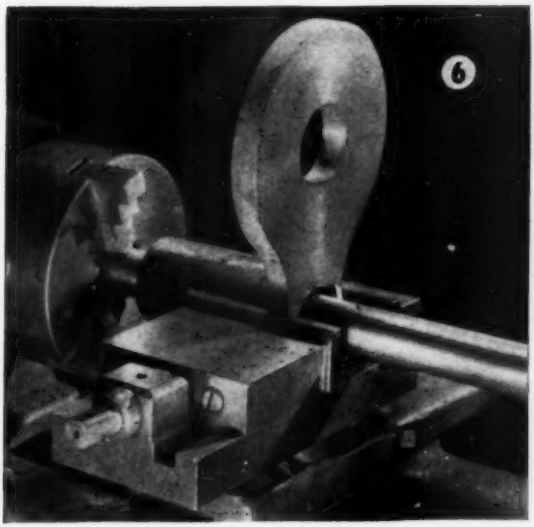






Working drawings of the parts for the bracket, spindle, end cap, and pulleys. The holes for mounting the motor are located accurately by applying chalk to the motor base and rapping it with a soft hammer while it is held in place on the bracket. If castings are unobtainable, bracket and housing may be made in two parts as suggested in the sketches at right



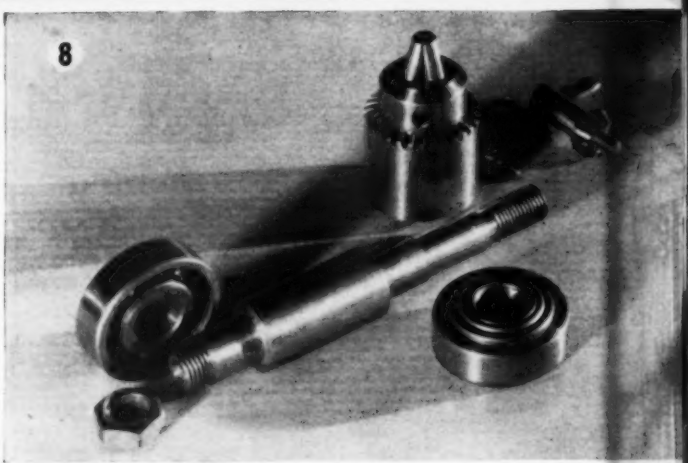


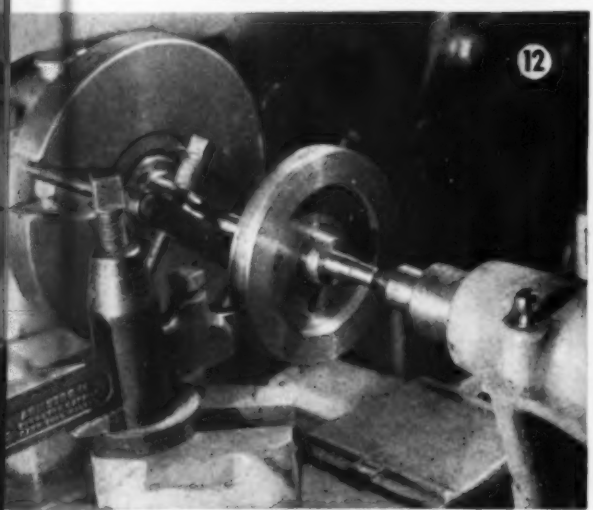
ing it accurately were located by chalking the base of the motor and rapping it with a soft hammer while it was held in place on the bracket. This left a chalked impression around the holes, and after being accurately centerpunched they were drilled. The holes were counterbored for fillister-head screws and the motor was mounted in place.

A steel spindle was accurately turned to the dimensions shown in the drawings. The outboard end was threaded in the lathe, as shown in Fig. 7, to receive the small precision chuck purchased for use on this accessory. Threads were also cut on the inboard end for a lock nut, shown with the spindle parts in Fig. 8.

An end cap for the spindle was made from a thin steel disk and set in place for drilling the screw holes into the casting, as shown in Fig. 9. Single-row ball bearings such as No. 202 are used. The rear one is secured with the lock nut, the spindle assembly slipped into its housing (Fig. 10), and the end cap screwed on.

Pulleys were turned from



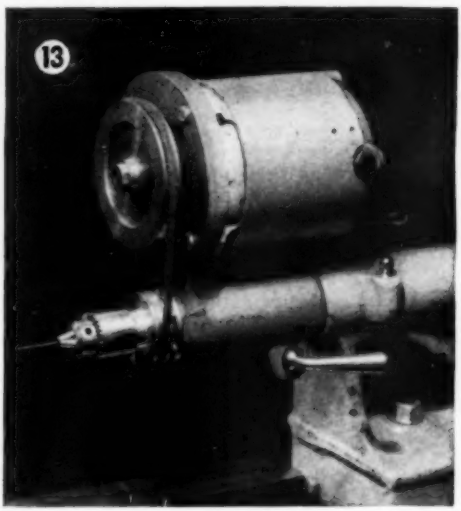


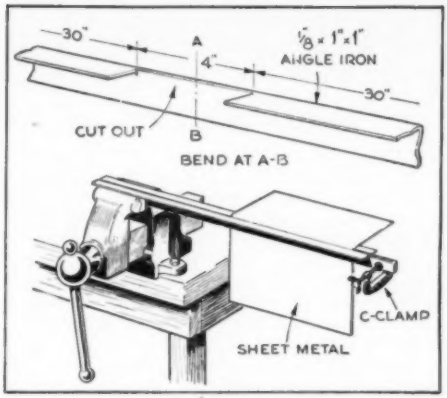
scrap stock, centerdrilled (Fig. 11), and mounted on a mandrel for the last finishing cuts as shown in Fig. 12. Great care should be used in turning these as they must be perfectly balanced and run dead true. The large pulley is secured with a nut and washer on the motor shaft, and the small one driven tightly in place on the drill spindle. With the chuck screwed on and an endless belt slipped over the pulleys, the drill is ready to mount on the tailstock spindle, as shown in Fig. 13.

In drilling very small holes, extremely high speeds and light feeds are recommended, particularly when a coolant is used. Except in drilling cast iron, high speeds cannot be maintained without a suitable lubricant, as pointed out on page HW 130. (Aug. '42 issue).

The best speed and feed for a very small drill is dependent on variable factors and no set rule can be laid down. However, a table on the page opposite will serve as a guide in determining the most effective speed for each job. Tables showing how fast drills of various sizes must be driven to attain recommended cutting speeds may be found in machinists' handbooks and manufacturers' catalogs. Small drills must be properly ground and honed for maximum efficiency.

At left, drilling the small pulley. Below at left, machining the large pulley on an arbor between centers. The completed drill with the belt in place is shown directly below



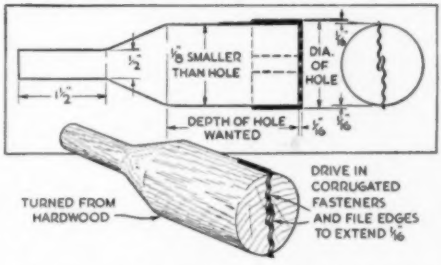


Jig Forms Right-Angle Bends in Wide Sheet-Metal Work

NEAT right-angle bends in sheet metal up to 27" wide can be formed easily with a simple jig made from a 64" length of 1/8" by 1" by 1" angle iron. A section 4" long is cut out of one side and the piece is bent double at the center of this part so that the sides touch. It is sprung apart to insert the sheet metal. With the open end fastened in a vise and a C-clamp at the other, as shown in the drawing above, the work is bent over by hand as far as possible. A mallet is then used to flatten the bend gradually to a sharp angle. The outboard end of the fixture is supported with one hand or by a length of pipe or lumber placed under it.—R. BOETTINGER.

Improvised Wood-Boring Tool Makes Smooth-Bottom Holes

IN MAKING a poker-chip rack and similar work, the boring of flat-bottom holes presents difficulties. A centerless wood bit will do the trick if the right size is at hand. In the absence of such a bit, a tool may be improvised by turning a piece of hardwood to the dimensions given below and driving into its end two corrugated fasteners with the edges filed and sharpened as shown. It is necessary to have the two bevels facing in opposite directions. The neck of the tool is placed in the chuck of the drill press and run at high speed. Because the steel in the fasteners is soft, it is best to bore the holes first with an ordinary bit and smooth the bottoms with the special tool afterwards. However, if kept sharp, the tool will do the whole job of boring in soft or medium-soft wood.—L. L. GIBSON, JR.



Two corrugated fasteners are driven into the end of the turning and sharpened to form cutting edges

CUTTING SPEEDS FOR DRILLS [SHOP PRACTICE]

The most efficient cutting speed for drills varies with the material being worked, the feed, and the coolant or lubricant used. For drills up to 1/4", the feed may be from .001" to .0045" per revolution. The following table gives suggested starting speeds in feet per minute for high-speed steel drills only. These figures will serve as guides, but the operator must be governed by the action of the drill and increase or reduce the speed accordingly. Carbon-steel drills should be run at about half these speeds.

Aluminum	250	Cast iron—hard	80
Brass and bronze	200	Tool steel	60
Cast iron—soft	120	Monel metal	50
Steel—soft	110	Stainless steel—hard	30
Malleable iron	85	Chilled cast iron	20
Magnesium and its alloys	300	Manganese steel	15

POPULAR SCIENCE MONTHLY SHOP DATA

Converting Oil Burners

CARL T. SIGMAN DISCUSSES THE PROS AND CONS OF AN

SHALL I convert my oil burner to coal or not? That is the question troubling some hundreds of thousands of users of oil fuel who live along the Atlantic seaboard and in Oregon and Washington. To these two areas, so far apart, oil has come largely by tankers, and there's the rub, because some of them are now at the bottom of the sea and others are carrying high-octane gasoline and engine oils to faraway places to help win the war.

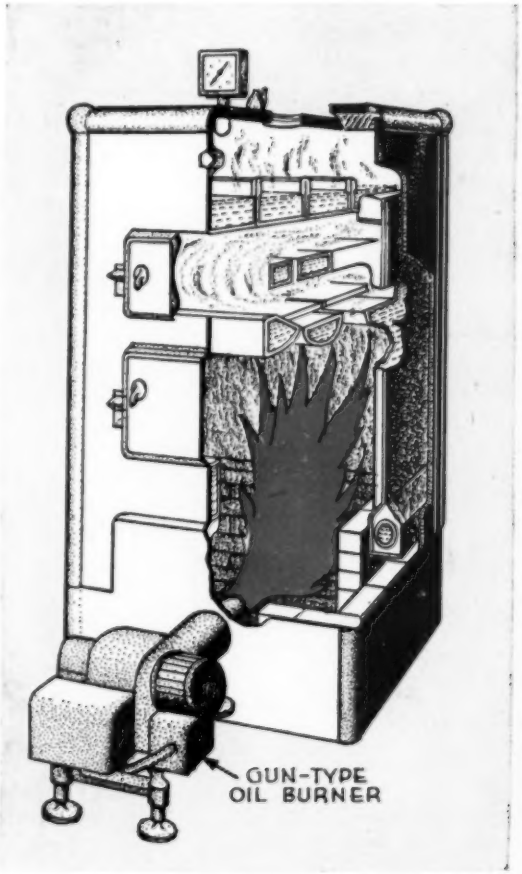
However, it's safe to say that 50 percent of the domestic grades of fuel oil consumed during the previous heating season will be available this winter. And it seems probable at this writing that there may be as much as 75 percent available, with an outside possibility of 85 percent. In other words, you will assuredly have to get along with 15 percent less oil, probably 25 percent less, and possibly as much as 50 percent less if you live in areas heretofore served mainly by tankers.

If you are fortunate enough to get as much as 85 percent of the oil you normally use, your best bet is to clean the oil burner and generally raise the efficiency of your heating system to its maximum. Then invest in storm windows and doors or weatherstripping, and close off unused rooms where possible. Keep bedroom doors shut at night when windows are open. Insist that children do not run in and out of the house, thus allowing precious heat to escape. Don't let hot-water taps run unnecessarily. Turn the thermostat down to about 55 deg. at night. Keep the temperature down to about 65 deg. during the day.

But if you are to get less than 75 percent of the previous year's requirements, look into ways of converting your furnace temporarily to coal or coke. Gas, of course, is an ideal though somewhat expensive fuel for automatic heat, but you may find it quite difficult to obtain a suitable gas burner. And your local utility company, which uses both coal and oil to manufacture gas—unless your community has the natural variety—has been affected by the same problems of transportation plus the stepped-up needs of war industries for gas. Therefore, it may very well refuse to give you more gas than you are now using. Consequently any conversion will almost have to be to coal or coke.

That being the situation, first consult your coal dealer to determine if he can guarantee you sufficient fuel in case you do convert. If he can, you have surmounted your first hurdle, but it will be difficult to get the automatic heat you have been accustomed to even if you have the money to spend, because on September 30 the manufacture of stokers ceased, though a few are still available. Besides, since the emergency is only temporary, you will naturally want to begin reusing your oil burner as soon as oil in satisfactory amounts is again available.

On these pages are shown two cutaway

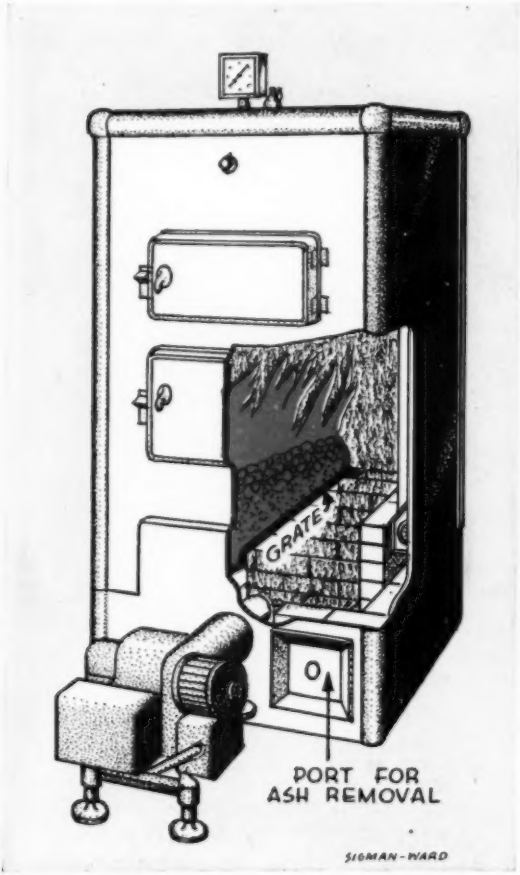


This type of oil burner can readily be converted to take coal. Of the 1,250,000 oil burners now in use, about half could be adapted, if necessary

to Use Coal or Coke

ACUTE PROBLEM BROUGHT ON BY WARTIME SHORTAGES

drawings of a conversion unit now on the market which can be installed in two or three hours in a boiler that previously burned coal. Once the installation is complete, you can shift back and forth from coal to oil and oil to coal in a short time as you have either coal or oil to use. This unit consists of 24" grate, bearing blocks upon which the grates rest on top of the fire-brick combustion chamber, a port for removing ashes, an ash hoe, and a clinker hook. You can readily see that this installation can be used only with a gun-type oil burner. Your thermostat continues to control the heat by starting and stopping the fan of the disconnected oil burner, thus providing a forced draft when more heat is needed. When your thermostat does not call for heat, your fire is banked.



One of the simplest kinds of conversion units. It costs from $30 to $40, according to size, and the work of installation takes from two to three hours

However, this system, which lacks a grate-shaking device, has obvious drawbacks. For the most efficient conversion, the oil burner should be detached, the fire-brick lining removed, and the old grates reset in place, if you are fortunate enough to have them stored away somewhere. More than likely, however, you are one of those who disposed of the grates and ash-pit doors long since. So note down the type, number, and size of your boiler and write the manufacturer to see if he can supply you with these missing parts.

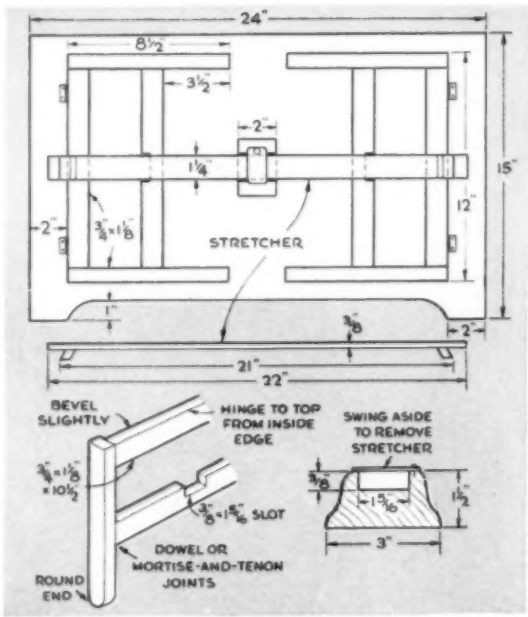
Many basic units were originally made to burn either coal or oil. It you have such a unit, you can get and install the interchangeable units with a minimum of bother, provided the manufacturer still has them in stock.

But suppose you can neither find your old grate nor buy one like it, your chances of keeping warm this winter with coal are still good. On the market are several types of round and rectangular grates with easily installed shakers which may be fastened by angles to the sides of the boiler or supported by legs resting on the ash-pit floor. With such units the use of stove, egg, or chestnut coal is recommended, while with the units requiring a forced draft you should use anthracite pea coal.

Since it has been estimated that from 43 to 79 percent of oil-burning, house-heating systems are potentially convertible, there is a patriotic responsibility on the part of people who can use coal to do so, because there simply isn't going to be enough oil to go around, not only this winter, but probably for a winter or two beyond. Some will say, "Why should I go to this expense and inconvenience simply because I have a convertible unit?" The best answer is the fact that some men are being ordered—but not all—to go to war simply because they happen to be within certain age limits and without grounds for deferment. Their responsibility is no greater than that of those at home. If your number comes up in the conversion draft and you can make the change, it's your duty to convert.

Bed Tray AND Folding Cot

Sturdy, Comfortable Items Made for Civilian-Defense Emergency Hospital Center in Easily Stored Units



The folding bed tray, above, used at home or in casualty stations, makes even handicraft work possible for the patient

TO MEET the need for a sturdy, comfortable cot for use in emergency hospital centers, C. E. Beane, of the Long Beach (Calif.) Homecrafters, designed the cot illustrated on the facing page. It meets requirements set up by Dr. Robert Wilcox, head of Medical Service for Civilian Defense for Long Beach. The cot folds for storage and can be used as a stretcher, although its width makes it impossible to place more than one at a time in an emergency ambulance such as a laundry or delivery truck.

Long Beach craftsmen, with the co-operation of a local cabinet shop, made 250 of these cots for the American Red Cross and various civilian-defense units. Such organizations, if consulted beforehand by clubs or individuals, will often defray the cost of materials.

The construction of the cot is shown in the drawing. A hardwood such as oak or ash is preferable for the rails. After roughing out the stock, round the ends of the rails on a shaper with a cove knife, if available, turning the piece through four quarter turns. Finish with file and sandpaper to comfortable handgrips. Bore the 5/16" holes for the carriage bolts, and mortise the rails for the crosspieces. These are, of course, tenoned to fit. Use a good grade of glue in assembling the frame.

The corners of the legs are rounded off as shown. Bore one end for a carriage bolt, and 6" from the other end bore a ¾" hole for the dowel rail.

Four blocks are glued and bolted to the frame. These serve as runners when the cot is used as a stretcher, and also prevent the legs from folding outward beyond the position shown.

Stain the wood a light oak, give it two coats of lacquer sealer or thin shellac, and wax well. Fold the canvas around the sides of the rails and tack it underneath, spacing the tacks ¾" apart.

The folding bed tray is a convenience for convalescents in the home as well as an excellent civilian-defense project. It simplifies the serving of meals to bed patients,

and also makes it easier for them to read, or otherwise amuse themselves.

Cut the top from ¼" plywood and nail to it one back and two side rails of ¼" by ½" soft pine or similar material. Make the leg frames from ¾" by 1⅛" stock, either with good, close-fitting mortise-and-tenon joints or dowel joints. Attach each to the top with a pair of small hinges.

The stretcher is of ⅜" material. Glue on the two stop blocks, spacing these to spread the legs under a certain amount of tension. The center catch is 1½" by 2" by 3", notched for the stretcher, and fitted with a pivoted piece of plywood, which is swung across the notch to hold the stretcher in place when the legs are down and the table is to be stored.—CHARLES H. HUNT.

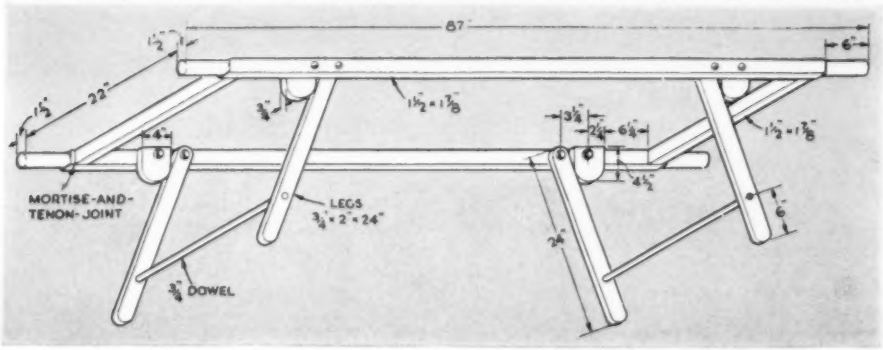
MATERIALS FOR FOLDING COT

No. Pc.	Description	T.	W.	L.
2	Rails	1½	1⅞	87
2	Crosspieces	1½	1⅞	24
4	Legs	¾	2	24
4	Runner blocks	¾	4	4½
2	Dowel rails	¾		22

Miscellaneous: 8—5/16" by 3" carriage bolts, 8 nuts to fit, 8 washers, 27" by 80" canvas, tacks, and glue.

Note: All dimensions are given in inches and are finished sizes.

Working in a local cabinet shop, Long Beach (Calif.) Homecrafters constructed 250 of these cots for use in emergencies by the Red Cross and civilian-defense units. They may be folded for storage



Gift

TWO-EVENING

By ERNEST R. DEWALT

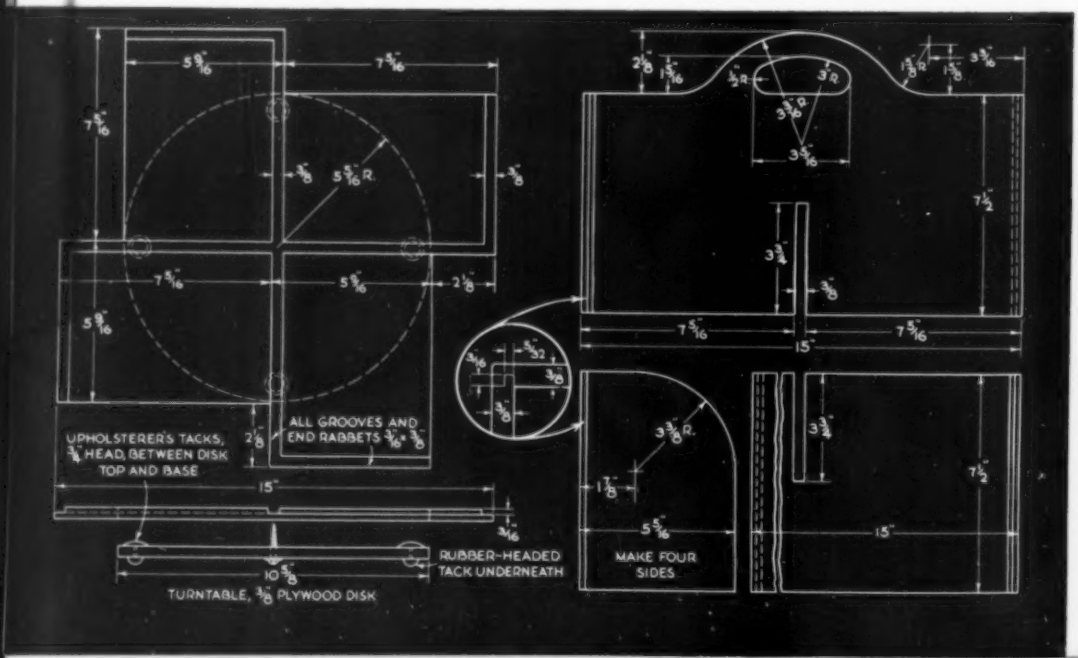
REVOLVING BOOKCASE. An ample quantity of reference material can be stocked in this small bookcase, making it a handy filing unit on the desk of student or research worker. Economy of materials adds purpose to the design in this day of material shortages.

The base is gotten out of a ⅜" by 15" piece of fir plywood. Cut 3/16" by ⅜" rabbets and dadoes (which cross themselves at right angles at their centers) on the circular saw against the rip fence. Next, cut rectangular pieces 2⅛" by 7 5/16" out of each alternate corner as shown in the plan view. The two dividing walls half-lap at the center and are similar in size, ⅜" by 7¼" by 15", except that one must be 1⅝" wider to allow for the handle. On alternate sides cut dadoes in from the ends as shown. Four similar curved sides are cut to fit into these dadoes and are glued in place. The entire assembly is then glued into the dadoes of the floor of the case, and nailed.

A 10⅝" disk is cut from ⅜" plywood, and a screw hole drilled in the center. This turntable has four equally spaced gliders (upholsterer's tacks with ¾" heads will do) on top, and four rubber-headed tacks underneath. Screw the turntable to the case so that the latter can revolve freely.

For an attractive finish, stain with Indian red oil color and turpentine. Wipe and wax several times when dry. Working time: five hours.

WINGED-TOP BOX. This novel cigarette box has two compartments for holding two full packages of cigarettes. The transparent plastic covers (glass may be substituted) permit vision into the box and add to the


UPHOLSTERER'S TACKS, ¾" HEAD, BETWEEN DISK TOP AND BASE
ALL GROOVES AND END RABBETS
RUBBER-HEADED TACK UNDERNEATH
TURNTABLE, ⅜" PLYWOOD DISK
MAKE FOUR SIDES

Craftwork

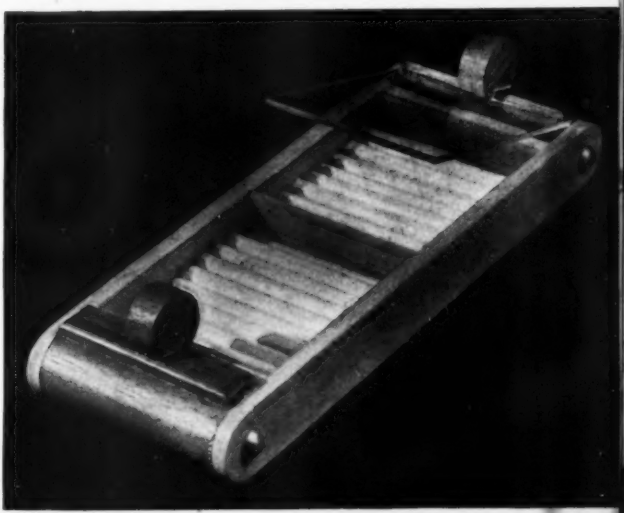
PROJECTS DESIGNED FOR ECONOMY IN MATERIAL

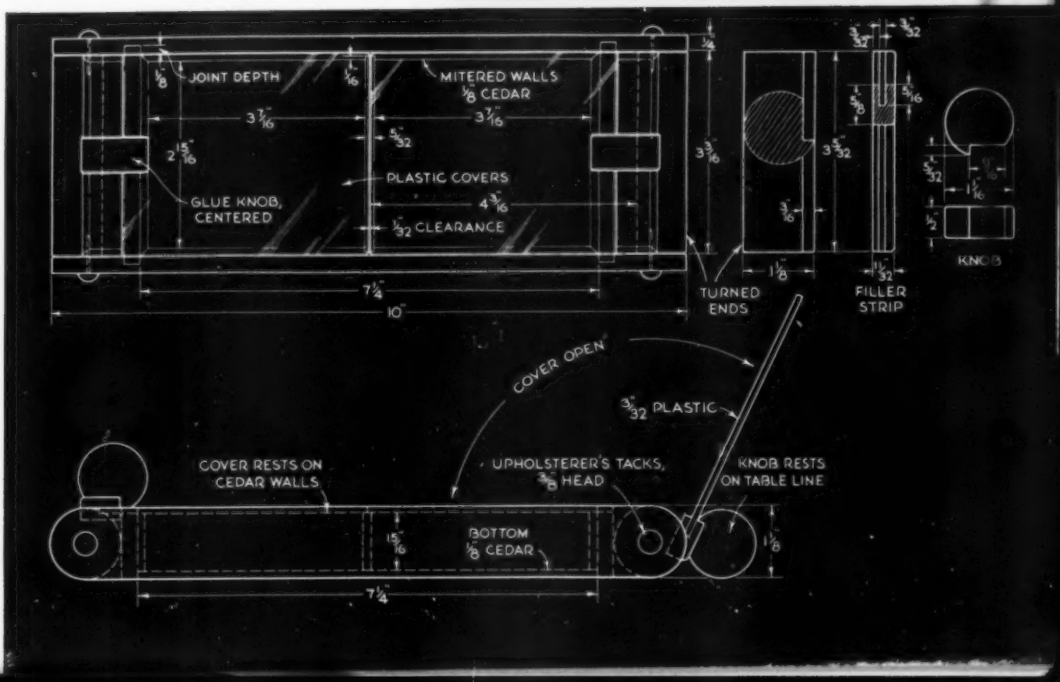
lightweight appearance. The covers fan out gracefully in a V-shaped design when the cigarettes are served, or, on the table, the knobs act as stops for the lids if they are left open.

The sides and ends of the box are ¼" whitewood, joined with ⅛" deep dado joints. A 3/32" undercut along the top of each endpiece is required to allow the covers to fold over flush when closed. The bottom of the box, the mitered lining, and the middle partition are, appropriately, of Spanish cedar. The bottom is set into the frame, and the lining pieces and partition are glued over it. Inside, the depth from floor to top of lining is 15/16".

Each plastic top is cemented into a 3/32" kerf, 5/16" deep, cut in a channel strip. This in turn is glued to a 3/16" rabbet cut as shown into each 1⅛" turned mahogany end roller. The rollers pivot on two lined-up upholsterer's tacks having ⅜" round, polished heads. The two knobs are also of mahogany, ½" wide and 1 1/16" in diameter, with a rabbet cut 5/32" deep to fit over the channel piece at the center. The entire cover assembly—roller, channel strip, and knob—is fastened at the overhanging curved extremities of the box.

Sand and rub the wood smooth before fastening the plastic to prevent scratching the

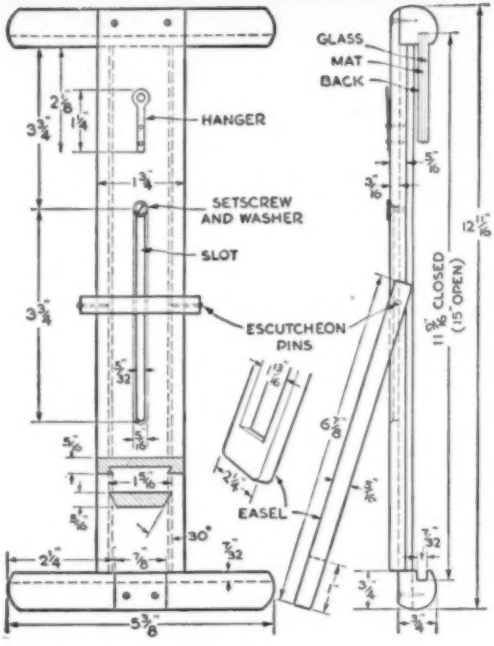




This simple frame is especially suitable for those portraits that need no outside embellishment to show them off. It may be used on the study desk or hung on the wall

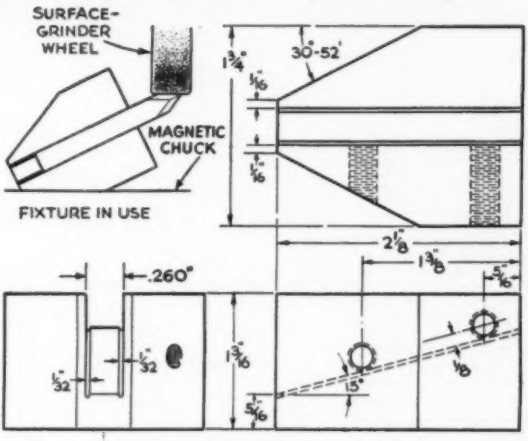
polished surfaces of that material. Apply two coats of clear lacquer, rub between coats, and wax. Leave the inside unfinished. Working time: four hours.

ADJUSTABLE PHOTO HOLDER. For portraits of men in service, as well as for any family pictures, this is in every sense of the word a fitting frame. It may be adjusted to several sizes and either hung by its clip on the wall or used as an easel frame. Two moldings of ⅜" by ⅜" maple, 5⅜" long, are rounded at the ends and joined to a dovetailed construction of two interlocking strips, which are fastened at the back by a setscrew moving in a 3¾" routed track. The longest adjustable extension for the glass mat and backing is 15", the smallest 11½". When it is 15" and the easel is to be used, reverse the frame to bring the metal hanger to the bottom of the picture. Finish: two coats of clear lacquer, waxed. Time: 3½ hours.

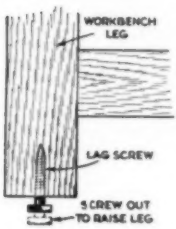


Single Grinding Gives Tool Bits Correct Clearance Angle

HERE is a simple type of fixture used by the gauge makers of a large arms company to grind tool bits to the correct thread angle for precision thread cutting. This is one of the handiest and most-used accessories in the tool room. It will hold a standard size ¼" tool bit so that it may be ground to the correct angle in a very few minutes without any extra work in grinding the necessary clearance. The one grinding operation automatically applies the correct clearance angle.



The fixture is usually made of machine steel and ground all over. It will not be necessary to harden this. The bottom of the tool-bit slot has run-out corners, or corner clearance, as shown. The screw holes are bored and tapped after the tool-bit slot has been put in and before the angle is cut on the sides. The angles are important and must be absolutely correct, but general dimensions need not be close except for the tool-bit slot, which should be approximately .260". In use, the fixture is held on the magnetic chuck of an ordinary surface grinder.—HENRY LARABY.



Lag Screws Keep Bench Level Without Blocks

IF A LIGHT bench must be level for precision work, but is not to be fastened to the floor, lag screws set in the feet as shown will allow it to be set up quickly without the use of blocks. Bore the holes to a close fit so that the screws turn in firmly for the last inch of their length. All that is then needed to adjust the bench is a small wrench and a carpenter's level. Use lag screws of a size to suit the thickness of the bench legs.—JOHN W. CAMPBELL, JR.

PATCHING PLASTER OR CRACK FILLER [*PAINTING*]

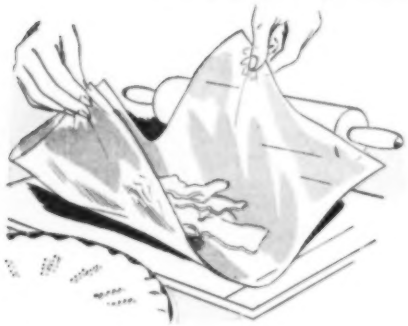
An inexpensive patching plaster or crack filler may be made as follows:

Plaster of Paris	1 lb.
Casein glue or canary dextrin	2 oz.
Whiting or Fuller's earth	2 oz.

Dental plaster of Paris, if available, is better than the ordinary grade because it does not shrink so much. Color with 4 oz. of dry French ocher or other dry pigments as desired. Mix intimately. Make up small portions to a paste with water. Apply to dents or bruises with a flexible putty knife, let dry hard, and sand clean. Reglaze if not puttied up level the first time.

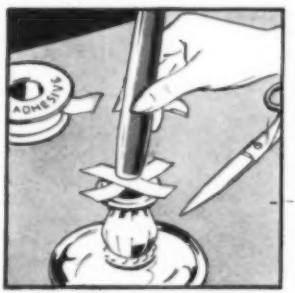
POPULAR SCIENCE MONTHLY SHOP DATA

KEEPING THE HOME



Dough rolled on waxed paper is more likely to be tender, for extra flour need not be sprinkled on to keep it from sticking. The paper is discarded when the job is done, and the board remains clean

One simple method of keeping "best" handkerchiefs separate from everyday ones so that they may be picked out quickly is to fold them into triangles and the others into squares when ironing

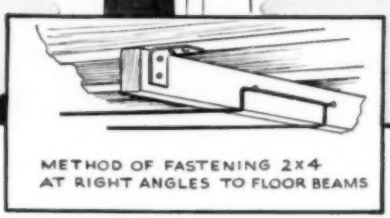


Candles won't wobble in holders when held by adhesive tape. Lay the tape in the form of a cross, adhesive side up, and press the candle against it as shown above

Used as a shaker, a tea ball will distribute powdered sugar evenly and quickly when a small amount is needed for sweetening fruits or garnishing cookies

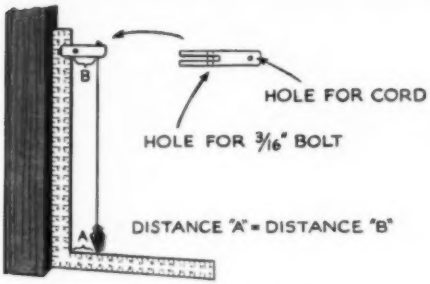
If special orders blow out of a milk bottle at your door, anchor them to a dowel with a pencil clip. The dowel should be long enough to stand up in the bottle

Parallel clotheslines are strung neatly on a basement ceiling by attaching 2" by 4" stock to two beams, as above, or across several, as at right. Nails support the line; the strips keep it from touching the joists

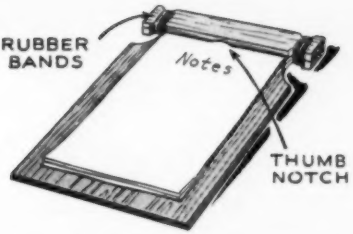


METHOD OF FASTENING 2x4 AT RIGHT ANGLES TO FLOOR BEAMS

SHIPSHAPE

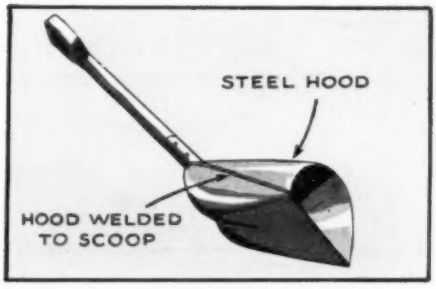


For an accurate emergency level, attach a wooden block to the blade of a framing square and swing a plumb bob from it. When level, A will equal B. Either horizontal or vertical work can be checked

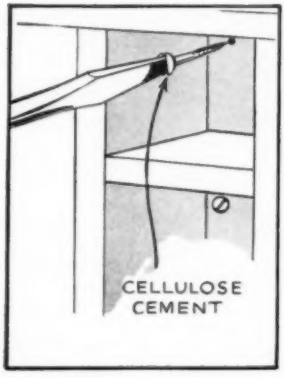


Plywood cut to required dimensions and notched as above makes a handy clip board. A strip at top, notched to match, is held by rubber bands

Placed over the end of a wooden stake, an old pipe cap will keep a hammer from splitting the stake when it is being driven into hard ground



Welding a hood onto an ordinary coal scoop in the manner shown above will make it doubly convenient for stoker firing. A No. 2 scoop so arranged can take 25 lbs. without spilling



Household cement dropped in the slot of a machine or wood screw will hold it to the screw driver where fingers won't reach

Chicken-coop wire tacked to the frame of a large packing box, or to a similar nailed-up frame, will hold a quantity of leaves and keep them from blowing when the lawn is raked. Use the box on a flat-bed wheelbarrow, securing it with nails or bolts if desired

Housekeeping Aids

FABRIC COLOR STENCILING and freehand work may be done at home with the aid of a new kit of 12 simplified textile dyes and accessories. The dyes, which may be mixed freely to obtain a wide variety of shades, are applied to the taut cloth, allowed to dry thoroughly, and set with an iron

PERFECTLY FILTERED COFFEE that will always be full flavored is made with this new one-piece, all-glass device by adding water gradually while it is still boiling. Six cups are made this way in four minutes

AUTOMATIC GARBAGE PAILS are available in 10- and 12-qt. models for installation behind a door of a cabinet sink or kitchen cabinet. The lid rises as the door is opened, and closes again as it is shut. The smaller unit has a removable galvanized can; the other has one of enamelware

Tips on Using

POCKET SUGAR CARRIERS enable restaurant patrons to take along extra sweetening for use in coffee or on desserts. Each carrier consists of a leather case and a glass bottle holding 1 oz. or three spoonfuls. A double size is available

SEWING MATERIALS and accessories can be kept in quantity and close at hand in neat arrangement in this period cabinet, which is built entirely by hand and, when closed, becomes a decorative article of furniture. Labeled drawers and compartments in it are so designed that they hold all needed items in a minimum of space

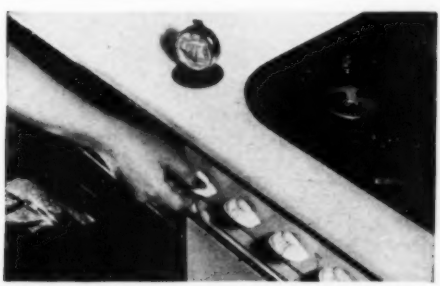
Your Kitchen Range

CLEAN the porcelain surface after each cooking. Wait for the range to cool, use warm, soapy water, and then wipe dry. Wipe off fruit juices, milk, or vinegar at once, as their acids cause stains.

Use the size burner to suit the utensil—the largest one for large skillets, the smallest for the coffee pot. Clean them periodically, or as often as food boils over, by soaking them in warm water to which a grease solvent has been added.

Less water and cooking time preserve vitamins and minerals and save fuel. One-pot meals, such as stews, also save fuel.

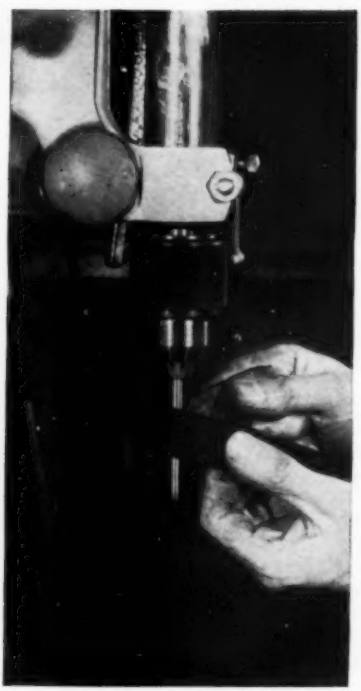
Preheat the oven to the exact temperature required, using the dial setting. Full oven meals—roast meat, steamed vegetables, and baked dessert—save work and fuel.



METAL-KITCHENWARE POLISH in powder form is available in a shaker-top container for quick use in cleaning and preserving skillets, pots, pans, and other utensils. This new-type polish is suited for copper, stainless steel, aluminum, brass, and nickel finishes and for solid metals

A prepared rust-removing chemical solution may be used on a lathe chuck. Such solvents are particularly convenient for cleaning machined surfaces of a drill press, saw table, or hand tools of various sorts, since they leave the metal surfaces as clean and bright as when purchased

Fighting



Above, a familiar type of cleaning-fluid bottle serves as an applicator for rust-preventing oil. At right, we see how a rod is quickly freed from rust and polished by rotating it in a drill chuck while abrasive cloth is held against it

RUSTPROOFING METAL ARTICLES [SHOP PRACTICE]

In general, paints and lacquers give maximum protection, but can be applied only to unmachined surfaces. Oil, wax and grease films provide protection for a limited period ranging from a few weeks to several months. Articles coated with such films may be wrapped in paper, cellulose film, or cloth as an additional safeguard. The following substances may be applied as rust preventives on steel and iron.

Articles packed for storage or shipment	*Articles subject to handling*
Petroleum jelly	Paint and lacquer
High-viscosity oil (chemically neutral)	Commercial antirust preparations
Petrolatum and oil mixtures	Soluble-oil emulsions
Paraffin oil and beeswax	Paraffin oil
	Chemical films such as oxides and gun bluing
	Paraffin wax

Rusty objects can be cleaned by hand or power wire-brushing, with abrasive cloth, steel wool, abrasive powders and polishes, and chemical rust solvents.

POPULAR SCIENCE MONTHLY SHOP DATA

Rust in the Shop

By WALTER E. BURTON

THE other day, while in a three-man shop, I noticed a pungent odor in the air. It got stronger as I walked toward a bench where a man was wrapping the small, high-speed steel milling cutters this shop makes.

"What's the funny smell?" I asked.

"It comes from this soup," he said, pointing to a coffee can. He picked up several of the cutters, dipped them into the "soup," and laid them on a piece of wire cloth to drain. Then he continued to wrap previously dipped cutters in small squares of waxed paper.

"Some kind of oil?" I guessed.

"Yes. Paraffin oil and beeswax, with a little penetrating oil to make it flow into the tight places. That's the penetrating oil you smell."

"But wouldn't the waxed paper alone protect the tools well enough?"

He laughed. "We used to think it did, until some of our customers complained about rust. With these things worth more than two bucks apiece, we couldn't afford to make many replacements. So we tried ordinary machine oil and several kinds of antirust preparations. This mixture seems to work best."

The experience of this small shop parallels that of large-scale industry. Most manufacturers today protect steel products against corrosion during shipment and storage, a measure doubly important now that tools and metal are vital to Uncle Sam. In the past, many shop owners and mechanics gave too little thought to rust, with the result that through sheer neglect they lost many a valuable tool.

Similarly, numerous household articles such as knives, garden rakes, stovepipe, lawn mowers, and the like were allowed to fall victims to corrosion. Enough grain drills, plows, hay rakes, and harrows to build a battle fleet have been allowed to rust to pieces on American farms during the past few generations. Today it is both necessary and patriotic to end this tremendous waste.

Rust prevention is a subject that cannot be settled with a few words or a single formula. Each problem demands individual study and may require the attention of an experienced engineer. Most of the major oil companies have on their staffs specialists who are available to advise large-scale manufacturers and shop operators on specific problems. However, the householder and small-shop owner usually needs to know only a few simple methods of fighting rust.

In cleaning corroded articles, a fairly fine wire scratch wheel is excellent for removing rust accumulations, scale, and bits of dirt.

Thick grease coatings are too messy to use on tools that are subject to much handling, but this mortising chisel and bit are to be stored away for several weeks, and an application of petroleum jelly or thick oil will keep both from rusting

Applying a rust-resisting coat of copper sulphide to a test-indicator post by use of an ordinary metal-bluing outfit such as may be purchased at large hardware stores

After wire-brushing, use fine abrasive cloth or steel wool to work up a polish. If a little sulphurized cutting oil is applied as a lubricant, a finer finish results. Finally, polish with crocus cloth or by buffing on a cloth wheel charged with rouge.

Various chemical rust removers, which dissolve away rust accumulations, are available. Such solvents are particularly convenient for cleaning the machined surfaces of drill-press and saw tables, as well as of hand tools. Penetrating oils are useful for loosening rust-bound parts, such as nuts or cap screws. A good mixture for this purpose consists of a thin lubricating oil cut with one quarter to one half its volume of kerosene.

It is, of course, best to prevent rusting in the first place by using suitable precautions. Iron and steel articles to be stored for long periods, shipped over salt water, or otherwise subjected to severe rust hazards, may be coated with a greasy material such as petroleum jelly or thick oil. One shop uses a high-viscosity, chemically neutral oil cut with about one tenth its volume of kerosene or mineral spirits to make it spread. The mixture is applied with a brush or by dipping.

Another shop mixes a similar oil with neutral white or light brown petrolatum at a high temperature, and thins the blend with kerosene or mineral spirits so it can be sprayed, brushed on, or applied by dipping.

Paraffin dissolved in naphtha or other solvents can be applied to form a hard, protective coating on shop and garden tools, automobile trim, and any metal article that remains unused or unhandled for a time. Thick grease coatings are messy to use on tools and household articles subject to much handling. Ordinary lubricating oils are often used, but are not very reliable. Paraffin oil gives only limited protection, in the opinion of some lubricating engineers. It is important that the coating, no matter what its exact nature, be chemically neutral, or at least not acid.

One shop foreman noticed that rejected parts coming from an automatic screw machine had not rusted during months on a scrap pile. He investigated and found that the soluble cutting oil used on the automatic was acting as an excellent rust preventive.

One gallon of such an oil, diluted with three gallons of distilled water, makes a good antirust emulsion. The article to be protected is dipped into it and drained. The oil coating penetrates into every crack and pore, withstands much handling, and if not rubbed off will protect the metal for months. It can readily be cleaned off by washing the article with warm water.

Some factories making nuts, bolts, washers, and other small parts use soluble cutting oils diluted with four or five volumes of water. The parts are dipped in the emulsion and passed on a conveyor belt through a furnace at about 750 degrees F. The oil oxidizes into a hard, black film that provides excellent rust protection.

Parts processed with the help of an oil emulsion should be *thoroughly* drained before packing. The film of soluble oil remaining affords adequate rust protection, once the water is eliminated.

Even experts do not agree as to the permanence of oil, grease, and wax coatings as protection against rust. However, new coating compounds are being developed to with-

Rust spots in this case are being removed from a saw blade through the use of a sulphurized cutting oil and a fine abrasive cloth. Such a method produces a finer polish than results from wire brushing followed by the use of steel wool or a dry abrasive

The use of a silica-gel dehydrating unit in a sealed container (such as a coffee can with gasket-sealed lid) will protect special bolts from rust

stand heat, cold, rain and sun, and their manufacturers claim that these will provide protection for long periods.

The rusting of a well-oiled or greased surface is a puzzling occurrence that can sometimes be traced to handling before the protective coating was applied. Perspiration from workers' hands has been known to attack steel vigorously, and it is sometimes almost impossible to eliminate all traces of it. A neutralizing cream applied to the hands before they come in contact with the work may be the answer to this problem.

Another cause of rusting under oil films, harder to guard against, is the condensation of moisture on the metal as the result of sudden temperature changes.

One small-shop owner protects tools against corrosion by bluing them in the same way that guns are blued. Occasionally he can do this by heating the article until it turns blue, then cooling it in water or oil. When this is not advisable, he employs a chemical process. Commercial bluing outfits are sold by sporting-goods stores and hardware dealers, but this shop owner prepares his own.

He makes a saturated solution of copper sulphate (blue vitriol) in water and labels it "Solution *A*." Marking liquids that deposit a coating of copper on steel may be used in place of this. A second solution of sodium sulphide in water is marked "Solution *B*." This should be somewhat below saturation strength. Fused sulphide, obtainable at drug stores, is satisfactory. Iron sulphide may also be used, or solution *B* can be made by dissolving 1 teaspoonful of common photographer's hypo in 1 oz. of water.

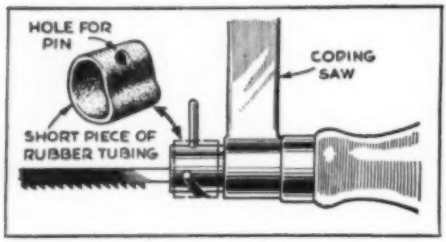
The shop owner cleans the tool to be blued with a grease solvent or caustic (lye) solution to remove all grease, and immerses it in solution *A* for a minute or two. An even coating of copper forms on it. Next he rinses the tool in water. To an ounce or so of solution *B*, he adds 15 drops of hydrochloric (muriatic) acid. This produces hydrogen sulphide, identified by its rotten-egg odor. He immerses the copper-coated tool in solution *B* until a uniform blue-black color is produced. Rinsing, polishing with a cloth, and applying a little machine oil complete the job.

Pipe and other iron articles buried in the ground are commonly protected by tar, asphalt, grease, or a casing of concrete. Old pipe can be cleaned and refinished with asphaltum paint. Clothesline posts, fence posts, and other iron or steel objects will last longer if the buried portion is set in concrete thick enough to resist cracking.

A rust-preventive finish for sheet-iron casings and cast-iron furnace parts is aluminum paint. Other heat-resisting paints for furnace use are available. Stove pipes to be stored for the summer should be wiped clean inside and out and then coated with petrolatum or a similar material. Before putting the pipes back into service, wipe off as much of this coating as you can—the rest will burn off.

The use of silica gel as a dehydrating agent to protect steel articles is now widespread. Silica gel in small bags or perforated metal containers may be kept in tool cabinets, instrument cases, shipping containers, and the like to absorb moisture that otherwise might cause corrosion. The gel is easily reactivated by heating, and lasts indefinitely.

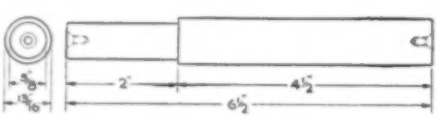
Blade Retainer Aids in Using Coping Saw for Inside Cuts

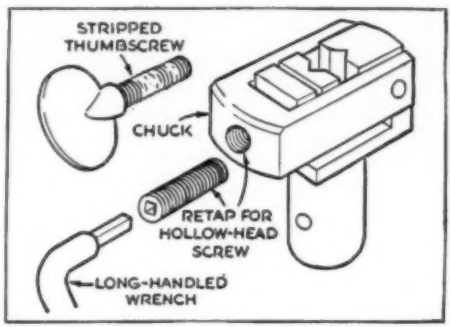


WHERE much inside sawing must be done, time is lost and delicate work may be broken by fumbling if the lower end of the coping-saw blade comes loose while the craftsman is trying to insert the upper end. A short piece of rubber tubing, with a hole punched in it so that it may be slipped over the rear pin as shown, will keep the blade in the groove and end this annoyance at the same time.—XURY R. SETTLE.

Guide of Steel Used to Start Die Close to Conduit Bends

WHEN installing conduit, it is sometimes absolutely necessary to thread a pipe close into the bend. However, even with a solid block die, which has the shortest follower or guide, the follower may hit and bind in the bend. The solution is to reverse both the stock and die, but then it is difficult to start the die straight because there is no guide. To overcome this, I use a piece of round steel as shown below. The $\frac{5}{8}$" end is slipped into the $\frac{1}{2}$" conduit and the pipe is threaded as usual. Other sizes can be made for larger conduit. A complete set costs little and saves time and trouble.—R. A. ANDERSON.





Use of Hollow-Head Setscrew Improves Scroll-Saw Chuck

TO END frequent stripping of the thumbscrew in a scroll-saw chuck, the hole was drilled and retapped, as above, for a standard hollow-head setscrew. The long-handled wrench makes tightening under the saw table easier.—R. M. WOODBURY.

PAINT SPOTS ON CLOTHING [*FORMULAS*]

For cleaning paint spots from clothing, the following formula may be used:

Chloroform	15 parts	Alcohol	100 parts
Ether	10 parts	Carbon tetrachloride	25 parts

These can usually be obtained from a drug-supply house or druggist, although it may be necessary to explain what you want the chloroform for. Keep the mixture in a tight, screw-cap can or bottle, away from fires.

Apply with a pad freely to any paint spot. Let soak under the pad for a few minutes, then rub from the outside area *towards* the center rather than from the spot outwards. When cleaned, brush vigorously with a dry whisk broom as soon as possible to avoid a "ring." Repeat a second time if required. This is a splendid "spotting" formula that is safe on all fabrics.

POPULAR SCIENCE MONTHLY SHOP DATA

How to Fix Cracked Masonry

REPAIRING AND WATERPROOFING BRICK AND STUCCO WALLS

By
William J. Ward, Jr.
Architect

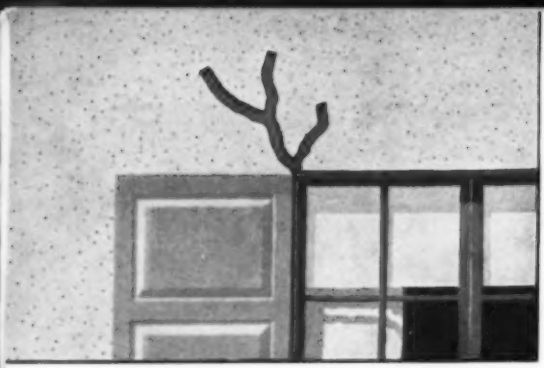
UNLIKE a cut finger, cracks in a building wall never heal. So, if there are cracks in the brick or stucco of your home, repair them now before winter sets in. Neglect may make the job much more costly later on.

Cracks in stucco may result from improper ingredients, mixing, or application, movement of the lath base, unequal settlement of the structure, or a combination of these things. Some may appear shortly after completion of the job; others years later.

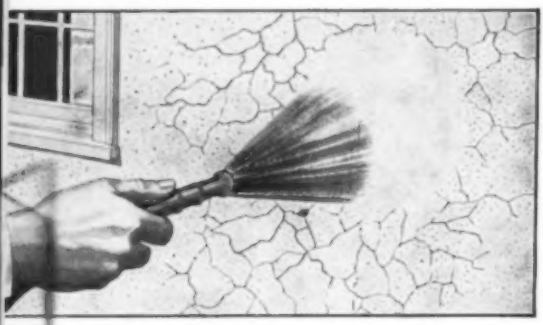
Once wide use was made of magnesite stucco for the hardness that its magnesium base imparted, but after some years the metal lath corroded and the stucco loosened and fell away. Softening and powdering of the surface also occasionally resulted. In either case, the lath and stucco must be removed and the job done over, or new lath and stucco applied over the old, the lath being nailed to the studs. While the latter process may be cheaper, difficulties will be encountered with window and door trim because of the added thickness of the wall.

For either a new application of stucco or a new coat over the old job, use a stucco made with Portland cement, sand, and water. Mineral pigments for color and so-called "plasticity materials" for workability may also be required. Sand should be free from appreciable amounts of loam, silt, soluble salts, and vegetable matter. Sand or aggregate, as it is known in the trade, may be somewhat coarser in the scratch and brown—the two undercoats of stucco—than in the finish coat. However, excessive fineness of sand in the finish coat is one of the principal causes of crazing and cracking. Water, the third and very important constituent of stucco, must be pure enough to be fit to drink.

For an original job with the finish coat in color, factory mixed stucco is best. In repairing where a color must be matched, commercially available colored cement may be used. If this cannot be obtained, mix only mineral pigments into the finish coat. Of the plasticity agents the most commonly used are diatomaceous earths, finely divided clays, asbestos flour, fiber, hydrated lime, and putty. Excessive quantities of any above a minimum for workability reduce



Open cracks with a cold chisel to form channels with straight sides that will lock in the mortar



Stucco having a multitude of hairline cracks must be dampened with a fog spray before resurfacing

When the old wall to be re-covered is smooth, two coats of stucco are required—the first dashed on, as above, just after the surface is moistened

strength and increase porosity of stucco.

Be accurate in measuring the ingredients of a mix. See that all batches are alike, and, where possible, mix materials in a machine mixer. Hand mixing is satisfactory if a batch is hoed back and forth 10 to 15 times after the water is added. Stucco mortar should stand at least an hour before it is used. Indeed, it may stand three hours if it is remixed frequently without adding water.

There are also certain details of application that must be followed or trouble will result. The first of the three stucco coats known as the "scratch" coat should not be richer than 1 part Portland cement to 3 parts sand. It should be ⅜" thick and cross scratched before hardening. If the scratch coat is to be applied on masonry, the wall should be clean and dry, and then dampened just before application of the scratch coat. Often this first coat should be "dashed" on with a whisk broom or fiber brush to exclude air from behind the stucco. Or, if the scratch coat is to be applied on metal lath, it must be thoroughly imbedded in the mesh to prevent rust.

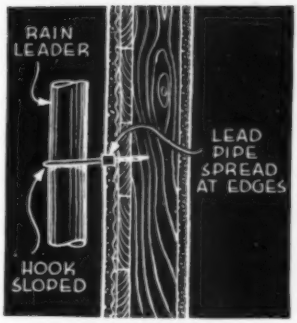
Over the scratch coat a ⅜" thick "brown" coat is added. It should be no richer than the first. Good practice dictates that it be slightly roughened with a wood float or cross scratched lightly, damp cured for at least two days, and then allowed to dry for at least seven days before the finish coat is applied. This finish coat, like the first two, should be ⅜" thick. It should consist of 1 part Portland cement and 3 parts white sand.

Where stucco applied over metal lath has cracked, it is possible that the lath has moved. These steps in installation will prevent that trouble: Surfaces to receive metal reinforcement must first be covered with waterproof building paper attached with large-head galvanized nails. Vertical joints in the paper should lap 6", and upper strips should overlap lower ones 3". The metal lath should be of a type in which the opening is not to be less than ¾" in the small dimension nor greater than 3" in the larger dimension, and not greater than 4 sq. in. in area. Securing the lath flat against the studs is poor practice. It should be furred out at least ¼" so that the stucco may be forced behind the metal. Use special furring nails; these should penetrate the studs at least 1". Wood furring strips cause weakness and cracking. The reinforcement must form a continuous network of metal. Lapping of the mesh shoud be at least 2", and laps should be wired securely.

Old stucco surfaces that are sound may receive a new finish to renew or change their color or texture. To accomplish either, wet the entire area and clean it with a

solution of 1 part muriatic acid and 6 parts water. Then wash thoroughly to remove the acid, and allow to dry.

Where the old surface is smooth, two coats of stucco will be required—the first dashed on just after the surface has been moistened. If the old stucco is unsound but not removable, cover the surface with waterproof building paper and metal lath and then proceed with the standard three coats.



Downspouts secured as shown here will not discolor stucco walls

Stucco that has a multitude of hairline cracks but is firm on the lath can be resurfaced. Dampen it with a fog spray, first being sure there is enough roughness to provide a bond. If the stucco is substantially sound but has one or a few cracks, these must be opened with a cold chisel back to the lath to form a channel with sides at right angles to the surface so that the mortar will be locked in. Before filling this channel, moisten it to prevent absorption of the mortar water and keep the patch damp for several days. Patching mixtures are commercially available, or they may be made with 1 part Portland cement to 3 parts sand and enough water for workability.

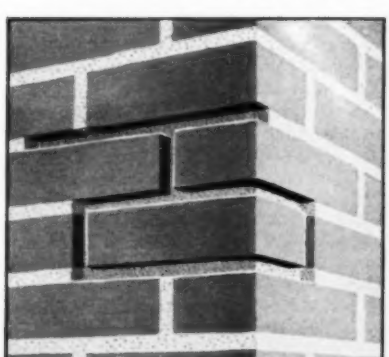
Leaks are frequently caused by cracks around windows and doors, at half-timber work, or in a gable end where the stucco meets the roof molding. Fill them with a caulking compound applied, preferably, with a caulking gun. In extreme cases it may be well to fill with tow or oakum smeared with white lead before caulking.

A waterproofer may be advisable on a porous stucco wall. This is no cure-all, but in some cases excludes dampness. Never depend on it if the stucco is fundamentally unsound. Commercial waterproofers are available both colorless and tinted, and should be satisfactory in closing hairline cracks.

To make your own waterproofer, shave from 6 to 12 oz. paraffin into a gallon of naphtha, benzine, or gasoline on a warm day and let it dissolve at air temperature. For fine-pore surfaces, add 3 to 6 oz. china oil to the gallon. Use caution, for these solvents are inflammable! Brush or spray on this mixture with the walls dry. Wait a day and repeat with a second coat.

There are paints that do a resonably successful waterproofing job. One of the best is Portland-cement paint, which comes in powder. Mix it with water, wet the surface to be painted, and apply. Two coats on Portland-cement stucco should be durable. Each coat must be dampened slightly as it sets, and the final coat kept damp for several days.

House paint can be applied to stucco, but it must be done properly and only where there is no likelihood of moisture entering from behind to push off the paint film. This paint can be applied only when the stucco is thoroughly dry. If there has been rain, wait three or four days. Don't start to paint, either, until the dampness of night has disappeared. To prepare the stucco, remove surface salts or crust with a wire brush. If there is positive indication of efflorescence, brush with a solution of 1



Rake joints to a depth of ½" or more if they contain wide cracks or show signs of weathering badly; then refill with mortar

Salt crust or stain from efflorescence may be removed by scrubbing with water or, if that fails, with a 10-percent muriatic-acid solution followed quickly with a water rinse

Dampness can sometimes be halted by drilling and filling the holes with a grout of cement and lime

part muriatic acid to 20 parts water. The lime in the stucco must be neutralized with a solution of 3 lbs. zinc sulphate to a gallon of water.

Mix your paint for the first coat with 1/3 spar varnish and 1/3 turpentine. For the second coat add a pint of turpentine to a gallon of paint. Apply a third coat as it comes from the can.

Another type of oil paint is one containing Portland cement, which should be applied exactly as recommended by the manufacturers. Still other paints are available containing special resins, gums, and plastics. If you happen to know that a paint has been used successfully in your neighborhood under conditions similar to your own, you might obtain the same material and follow the directions on the can.

Following are some suggestions for the selection of coloring materials when the color is to be mixed directly into the stucco.

For *white* use white Portland cement.

Brown, burnt umber or brown oxide of iron. Yellow oxide of iron may be added for modification.

Buff, yellow ocher or yellow oxide of iron. Red oxide of iron may be added in limited quantities.

Gray, small quantities of black iron oxide, manganese black, or Germantown lampblack.

Green, chromium oxide. Yellow oxide of iron may be added.

Pink, small quantities of red oxide of iron.

Rose, red oxide of iron.

Cream, yellow oxide of iron in small quantities.

In any case, for maximum brightness and clearness of color and for light shades, the stucco should be white Portland cement.

Where stucco is applied on masonry, lack of uniform "suction" in either the scratch or the brown coat causes discoloration. "Suction" is the term applied to the drawing of the moisture from the stucco to the masonry base, which will occur uniformly if the wall is uniformily dampened with a fog spray before the stucco is applied. But if drying is spotty, the finish coat also may be spotty.

Improper flashing and corrosion of flashing or metal attachments may also cause discoloration and streaking. Downspouts and gutters must carry off water without leaking, and the downspout should be secured as shown in one of the illustrations.

Inferior or improperly mixed pigments are a third cause of discoloration. Changes of materials or proportions during application may have the same result, as will variations in the amount of water in the mix, failure to provide adequate drips and washes at sills and trim, and the addition of water to drying mortar.

Brick houses, like stucco, are subject to efflorescence—a deposit of water-soluble salts that shows up as a whitish crust or stain. The salts are alkaline, and they may be present as well in hollow tile, concrete, or mortar. Tests indicate that the brick itself is less liable to effloresce than the mortar in the joints. The crust or stain may be removed by scrubbing with water or, if that fails, with a 10-percent muriatic acid solution, followed quickly with a water rinse.

If efflorescence continues past the time when excess water during construction might cause it to appear, it is something about which to be concerned. It is then an indication of internal dampness, which may get through the face or back or even the entire wall. Defective flashing, gutters and downspouts, faulty copings, or improperly filled mortar joints may be the cause.

Check all the flashing within range of the leak. If you find faulty work, correct it promptly with such available materials as asphalt felt or caulking compound. This will probably serve for several years, and later the repair can be made permanent. Durable wood gutters and downspouts can replace metal ones that are beyond use. Coping may require reflashing or repointing at the joints.

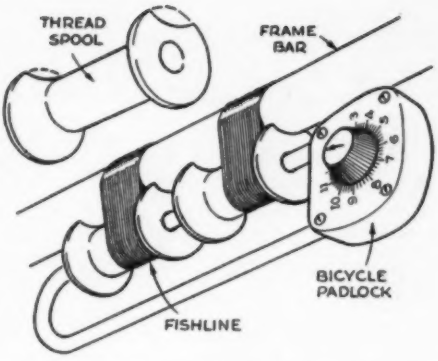
Hairline cracks, sometimes called "separation cracks," may be caused by incomplete bond due to separation of the water from the mortar—that is, rising of the mortar to the top of the joint as it sets—or they may be caused by the absorption of the mortar water by the bricks, threby giving an incomplete bond. These can be reasonably well plugged by a waterproofing liquid.

If the joints have appreciably wide cracks, or show evidence of poor workmanship or serious weathering, rake them to a depth of ½" or more, and refill with mortar of 1 part Portland cement to 3 parts sand. Dampen the surface before the operation

and keep the work damp afterwards for several days.

If the wall is solid brick, you may find a condition in which dampness exists in the foundation and lower part of the walls above grade. This dampness may be traced to improper drainage about the house or lack of waterproofing precautions for the foundation wall. Drain tile may be laid along the footings, or membrane waterproofing applied, if necessary, on the outside face of the foundation wall. But if dampness is reaching the brickwork by capillarity and there is no other serious difficulty, bore holes ½" in diameter every 4' or 5' in a horizontal mortar joint a few courses above the bottom as shown in one of the illustrations. Drill these holes about 4" deep to reach the point behind the face course. Fill alternate holes with a grout of cement and lime containing 2 percent ammonium or calcium stearate by weight, and apply pressure until it appears at intermediate holes. Then seal with ordinary mortar.

Occasionally water enters near or at the top of a brick-veneer wall and dampens the plaster at the bottom. If a check shows this to be the case, remedy by drilling ¼" holes near the bottom of the brickwork along a horizontal joint in such a way that any water settling there will drain out.



Bicycle Lock Held on Frame in Handy Spool Socket

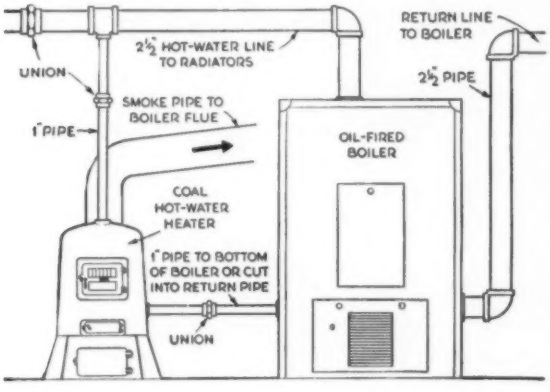
A BICYCLE padlock, if carried in a pocket, is hard on clothing; if simply snapped to the frame, it is noisy. Here is an easy way to avoid both troubles. A couple of thread spools are sawed as shown to fit snugly against the bottom bar, and are lashed to it with tire tape or with fishline, as illustrated. When all is tight, give the spools and cord two coats of spar varnish or enamel.—HARVEY OLANDER.

Coal Booster Saves Fuel Oil in Hot-Water Heating System

WHERE the supply of fuel oil is limited or shortages are likely, this simple method of "converting" a hot-water heating system so that it operates largely on coal may mean the difference between a comfortable home and one that is barely livable. No changes are made in the oil-fired furnace, nor does it matter whether it is one designed to burn oil or converted to do so. The change back to complete oil operation can be made easily at any time fuel oil again becomes plentiful.

A medium or large hot-water heater, such as can be purchased at little cost secondhand, forms the booster unit. The delivery line from the top of this is cut into the hot-water feed main from the top of the oil-burning boiler to the radiators, as shown in the accompanying drawing. From the bottom of the booster a pipe is run into the bottom of the boiler or cut into the return line from the radiators, whichever is easier.

With this hookup, the coal-fired booster really becomes the heating plant, remaining in constant operation. The oil burner becomes an auxiliary unit. When the coal fire is unable to keep the temperature of the house at the level the thermostat is set for, the latter automatically cuts in the oil burner for a time.—HUGH B. AYER.



Connections for a coal booster in a hot-water heating system are shown at left. Cut the lower pipe into the return line if more convenient

MODEL-RAILWAY SWITCHWORK

2. THE LEADS

By DAVID MARSHALL

TO BUILD any turnout (see Fig. 1), the first step is to fashion the tongue of the frog; and this you may do by simply mitering the two rails *FG* and *FH*. In our previous discussion of the frog (page HW 304), we set forth an easier method. But the method is not vital; the essential thing is to bring the two rails together at the required angle.

Spiking the so-called "stock rail" to the ties at a switch in the elaborate layout of the New York Society of Model Engineers

THE STARTING POINT. We begin construction of the turnout by spiking down the stock rail *AB*, which can be of any length whatever—for this is part and parcel of the main route, and only accidentally a part of the turnout. Immediately that's done, we establish our true starting point (*F* in Fig. 1).

Having established *F*, then, our next step is to lay the rail *G*. A slight complication arises, however, as the result of our simplified method of constructing the tongue; and so, for the moment, we turn to Fig. 2. Here we have the tongue of a No. 6 frog—its two parts angled together at a 6-to-1 slope. Now the point is, that the *G* rail, when handled in this fashion, does not continue westward to *F*, but stops at *P*. The difference is slight, but still one that we ought to allow for. The difference, in the case of a No. 6 frog, is six times the breadth of the head of whatever size rail you happen to be working with; seven times in the case of a No. 7 job; eight times in the case of a No. 8. It may be as great as $\frac{3}{8}$" (in O gauge), or it may be as little as $\frac{1}{4}$" (in HO).

From *P*, then, the *G* rail is laid strictly to gauge with *AB*, spiked firmly and permanently to the ties. And that's half the tongue in place.

COMPLETING THE TONGUE. Now the *H* rail has been prepared as in Fig. 3 (and as described on page HW 305) to hook over the end of *G*. In addition, *H* must be absolutely straight and at least 7" long. And it must be laid to a straight line which, if continued, would strike *AB* at a 6-to-1 angle.

G and *H* must come together with precision at *P*, but for the rest, there need not be a snug fit. The main thing is to effect a contact, a kind of hinge, at *P*, and then to follow the correct slope. If the result of this is to open up an otherwise perfect seam, you can fill the void with solder. (Not, of course, that solder is recommended, but that solder is better than a perfect fit that results in a false alignment.)

When the *H* rail, accurately aligned, has been firmly spiked in position, the next step is to cut off the unwanted portion—so that the line from *P* to *F* (see Fig. 2) forms a continuous straight line with the upper edge of *G*.

It's the upper surface of the rail heads that we see in Fig. 2. They form a perfect tongue. For the sake of the record, however, we note that the cut from *P* to *F*, leaves *F* unsupported by any web (see Fig. 4), and allows one of the flanges to extend beyond *F*. The loss of the web is of no importance, however, and (once the wing rails are in place) cannot be seen; and the sliver of flange is simply cut away at a slight angle

back from *F*. That solves the difficulty.

Finally, to complete the tongue, the upper, riding surface is to be filed down gradually as it approaches the point, so that *F* is slightly below rail-high and below the treads of the wheels, which ride on the wing rails at this point. Thus the weakest part is protected, and the tongue takes over an increasing portion of the load as it becomes broader and stronger.

THE DIVERGING LEAD. In both Fig. 1 and Fig. 5, the diverging lead rail appears as *M*. Its length is determined by the size of the frog. Including 1″ in every instance for forming the wing rail of the frog, the O-gauge figures for the several frog sizes are: No. 6, 7⅝″; No. 7, 11½″; No. 8, 13 1/16″.

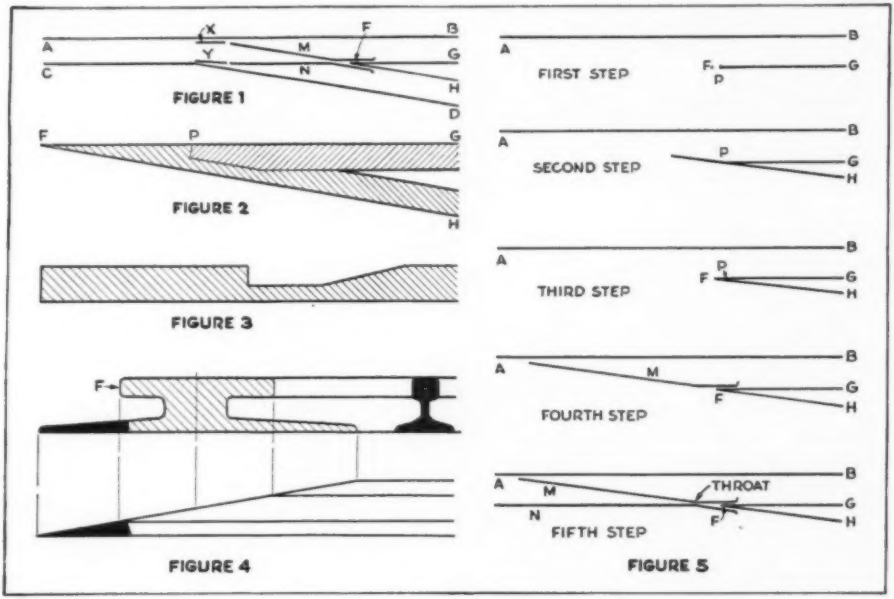
The preparation of the diverging lead consists in (1) bending back 1″ of the rail sharply, so as to form an angle supplementary to the angle of the frog; and (2) drilling a hole through the web at the other end, to receive a bolt for fishplates. It must be added that *M* (apart from the wing rail that flares out of it) is an absolutely straight rail.

It is in position when the wing rail lies parallel to *FG*, with a flangeway of 5/64″ between them; and when the main portion of the lead forms an absolutely straight line with *FH*. In that position it is to be nailed down fast over a distance of 3″ (4″ or 5″ in the case of a No. 7 or a No. 8 frog) from the wing rail toward *AB*. When the wing rail, too, is firmly spiked, it becomes a hard job to budge any of it.

Yet the opposite end is not spiked—and this end comes mighty close to *AB*. Between *AB* and *M*, however, there must be a flangeway of ¼″, and we now create this by forcing a ¼″ block of wood between the two. Under this strain, *M* develops a very slight curve toward the middle—and this curve is absolutely accurate from the engineering viewpoint. Quickly, then, you spike her down, just as she lies, and knock the block of wood away.

THE MAIN LEAD. The main lead (*N* in Fig. 5) is prepared precisely as was the diverging lead, except, of course, that the wing rail is bent off to the other side, and the hole is drilled a little farther in from the end. Incidentally, the main lead is to be exactly as long as the diverging lead it's paired with.

The same flangeway must be allowed between *N* and the *FH* rail, and where *M* and *N* come closest together (to form the *throat of the frog*) the same interval of 5/64″ must again be allowed; but otherwise *N* is simply laid to gauge with *AB*. And after that, all you have to do is to cut a bit off the end of *N*, so that *M* and *N* will both terminate in a straight line drawn perpendicular to *AB*. You square them off accurately—for they are to be the gateposts on which, presently, you will hang your switch.



Having Fun

FASCINATING HOBBY

Much of the fun of microscopy is in collecting and preparing specimens. Above, dehydrating a piece of animal tissue with dioxan preparatory to slicing. Right, "fishing" for specimens of fresh-water life

By WALTER E. BURTON

IF YOU could increase the size of a baseball a thousand diameters, it would cover an acre of ground. Yet, with an ordinary laboratory microscope such as physicians use, you can make a tiny diatom or bacterium look that much bigger than it actually is!

That is why a microscope is a fascinating instrument for the amateur scientist: it lends wings to his eyes, enabling him to see things which, without it, would remain hidden forever. This article is designed to answer some of the questions that are

Home Science

With an Instrument and Some Inexpensive Equipment, You Can Start a Collection

The microscope at the left is a professional-type instrument. Note the revolving nosepiece with three objective lenses which can be interchanged by turning. A 10-power eyepiece rests on the table

Handling a specimen with homemade dissecting needles consisting of stiff sewing needles mounted in wood or plastic handles. The microscope shown is a typical instrument of the amateur variety

with a Microscope

OPENS NEW WORLDS OF WONDER TO YOUR EYES

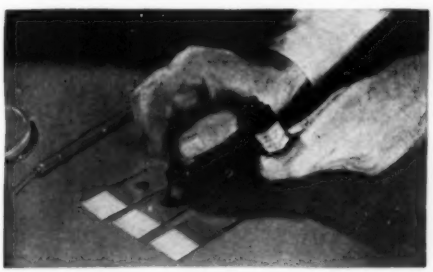
commonly asked by persons who are thinking of taking up the thrilling hobby of microscopy.

It usually is price that determines which kind of microscope the amateur will get. The lowest-priced models are, of course, the amateur-type microscopes. However, it sometimes is possible to obtain a used instrument of the "professional" type about as cheaply. Such microscopes may be quite old but still be satisfactory from a performance standpoint. For the well-filled pocketbook, there is a wide variety of new, standard instruments available. These range from relatively simple "student's" models to binocular research microscopes having as many controls as a battleship.

Inexpensive amateur instruments of the better type, although not sporting as many conveniences as they might, are capable of excellent performance. They have reasonably well-corrected lenses, and magnifications sufficient for most practical purposes.

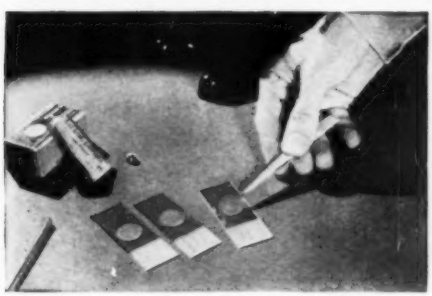
If you find a used, standard microscope in workable condition for, say, $10 to $35, it will serve you well. If the instrument has standard "society" threads, it can be fitted with modern objective lenses; and these, together with good eyepieces, will make it perform as well optically as a brand-new microscope. However, the original lenses may be entirely satisfactory.

The objective lens of a microscope is the one at the lower end of the tube, next to the object being examined. It may consist of several individual lenses arranged in a single tube or mount. Microscopes with revolving nosepieces carry two, three, or four objective lenses that can be switched into position by a simple turn of the nosepiece. The ocular or eyepiece is the lens or system of lenses at the upper end of the tube, near your eye. The total magnification of the microscope is the magnification provided by



Staining increases beauty of specimens by adding color, and also brings out the structural details

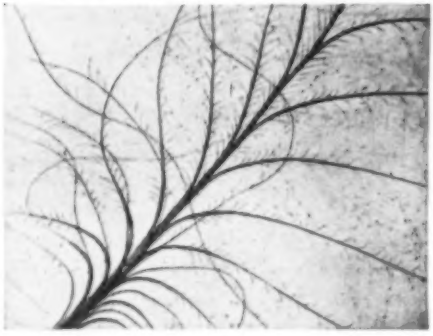
Canada balsam provides a transparent medium for mounting specimens and cementing covers to slides



With the specimen and balsam in place on slide, the thin cover glass is placed on top of them

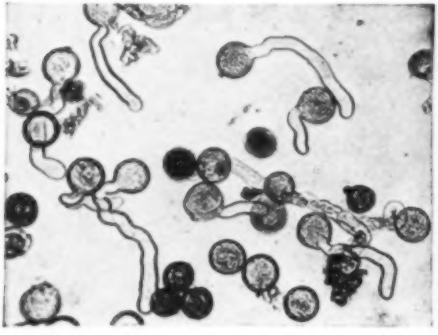
Identified by labels, slides are kept for study. Amateurs are proud of their specimen collections

Plant stems are interesting subjects. This is a thin cross section of a stem of "Dutchman's pipe"



A bird feather at moderate magnification is a thing of rare beauty, as in this photomicrograph

Life unfolds its inner secrets. Here pollen of the trillium flower is germinating in a sugar solution



the objective, multiplied by the magnification of the eyepiece.

The question of what magnification to use is a bit difficult to answer, because the performance of a microscope depends not so much on the magnification as on the definition of the lenses. Definition is the degree of sharpness with which you see anything.

Therefore, the best bet for the amateur is to obtain a microscope that has good definition, even if it does not have a very high magnification. A surprising amount of work can be done at magnifications ranging from 25 to 100 diameters. The average "amateur" instrument should not be used much beyond 400 or 500 diameters. When you select an instrument, try it out before you plunk down your cash, and if it doesn't show a fairly sharp image at, say, 100 diameters, don't plunk. Probably 85 percent of the observing an amateur microscopist will do will fall within the range of 25 to 250 diameters.

The substage mirror, which reflects light up into the microscope through a hole in the stage, can be either flat or concave. In the higher-priced instruments, both kinds of mirror surfaces are provided. A substage condenser is a lens or system of lenses that concentrates light from the mirror into a small spot where the object being examined is held. For low and medium-power work, a condenser is not essential. The substage diaphragm is a gadget for regulating the size of the hole through which light passes to the object. It influences the contrast, depth of focus, and sharpness of the image.

In addition to a microscope, the beginner will need few tools and supplies. These might include at first:

A dozen or so 1″ by 3″ glass slides on which to place objects being examined.

Crystals of potassium chlorate by polarized light. The gorgeous colors do not show in this picture

Cover glasses, which are very thin pieces of glass, for placing over the object to hold it flat, to preserve it, or to make the liquid surrounding it spread out into a thin film. For a start, you might get some 22-mm. square, No. 2 cover glasses. They are usually sold by weight, a half-ounce being plenty at first.

Tweezers for picking up small objects, cover glasses, etc. are almost a necessity. You can get them at the dime store. Pointed ones are preferable, if you have only one pair. If possible, obtain a kind that won't rust.

A dissecting needle can be made by sticking a stiff sewing needle eye-first into a slender wooden or plastic handle. The handle of an old toothbrush can be used, if you have a drill to make a small hole in it. Fasten the needle with pyroxylin cement, balsam, or something similar.

Ordinary kitchen knives, carefully sharpened, can be used to cut thin sections of plant stems. Here celery is being cut

Canada balsam is a refined pitch used for cementing cover glasses to slides, and for surrounding the specimen. It has about the same optical refractive index as glass, making the object appear as if it were embedded in solid glass.

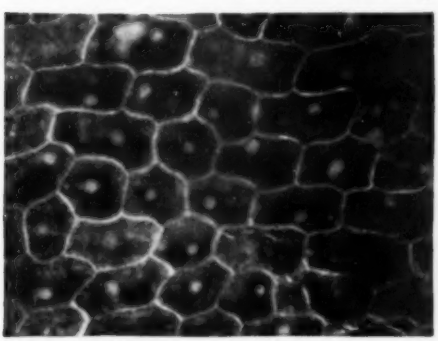
Xylol or xylene is used as a solvent for Canada balsam, for thinning it, washing it off your fingers, etc. Xylol is also used in preparing some specimens for mounting. It is not very expensive. Caution: do not let it come in contact with paint or varnish surfaces, for it will dissolve such finishes. Keep it away from fire, too.

Alcohol (ethyl or grain, usually) is employed for dehydrating tissue, killing and fixing bacteria, and for a great many other purposes. The ideal type is pure, unadulterated grain alcohol; but try and get it! For a large variety of operations, denatured alcohol can be used. Lately, another solvent, dioxan, has come into use.

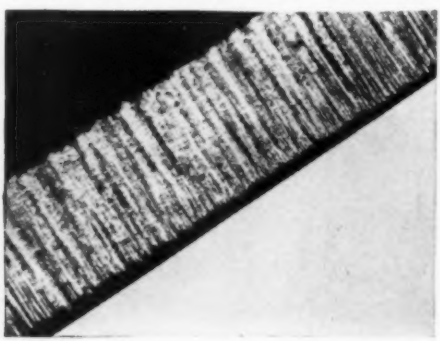
And, of course, your equipment should include bottles, capped jars, and boxes for carrying and storing specimens.

With this equipment, you are ready to start one of the most exciting, interesting and pleasant experiences of your life. At first, don't try to see everything at once. Start with the lowest magnification on your microscope, and examine commonplace and easily handled objects like feathers, bits of cloth, the edges of plant leaves, small insects, bee wings, mosquito legs and mouth parts (at last, revenge!), flower pollen, and the edge of a razor blade. Later, you can graduate to such things as pond life, animal and plant tissues, and even bacteria.

Cells and nuclei in onion skin show up plainly. A weak tincture of iodine may be used for staining



Edge of a razor blade as seen by the microscope. The cutting edge is toward the white area of print



Tests Show How Your Heating Plant Works

WHERE there's soot, there's wasted fuel—a good thing for home owners to keep in mind this winter. Why it forms, and how to prevent it, may be seen in the first of the simple experiments on these pages. Others illustrate the difference between heat and temperature; demonstrate how hot-water and warm-air heating systems work; and explain why homes need humidification for health and comfort in winter.

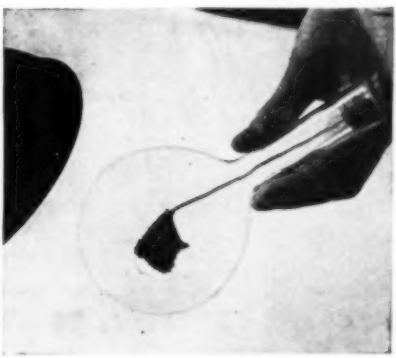
Like many real home-heating plants, the rudimentary models of hot-water and warm-air systems shown here operate by gravity. Where more positive flow is desired, water-circulating pumps or air-circulating blowers, respectively, may be added to boost the heat-carrying medium along to where it is needed.

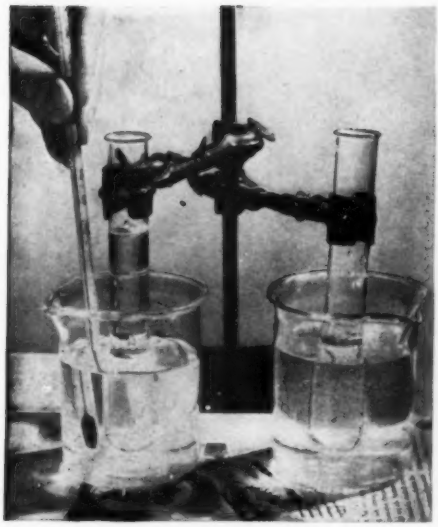
SCIENCE STUNTS

SOOT WASTES FUEL. Hold a piece of bright metal over a candle flame until black soot covers it. To prove that the soot is unburned fuel, direct a hotter flame upon it as shown, by reinforcing the candle flame with a simple blowpipe. The black deposit becomes red-hot and burns completely, leaving the metal clean. Likewise, smoke and soot from your home heating plant indicate imperfect combustion. Proper firing and draft regulation will eliminate fuel waste, smoke nuisance, and the fire hazard of sooty chimneys wherever coal is used. In systems burning oil or gas, adjustment of air controls serves the purpose.

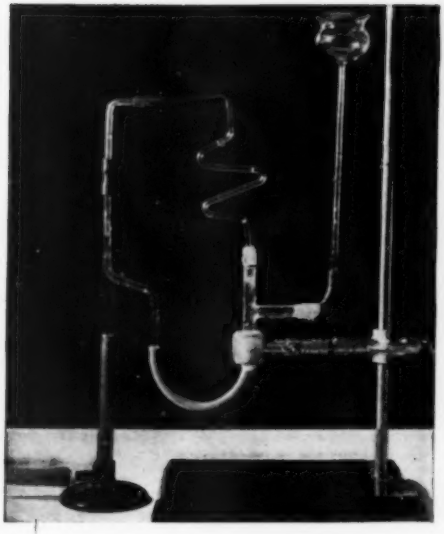
RADIATOR PAINT. Connect an inverted flask, blackened in a candle flame, with tubing and a scale as shown below. A little colored water in the tubing completes an "air thermometer." Coat a tin can with aluminum bronze on one side, and ordinary paint on the other. Fill the can with boiling water and expose each side alternately to the thermometer. Aluminum-coated metal gives off less heat.

WINTER HEAT DRIES AIR. Blow into a chilled flask, and promptly close it with a stopper holding cloth dipped in cobaltous chloride and dried. Its pink color shows the air moist. Warm the flask and the cloth turns blue, showing dry air. No moisture has left the flask, but relative humidity drops.



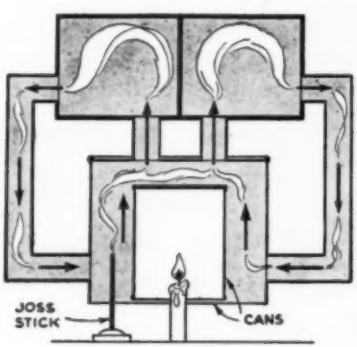


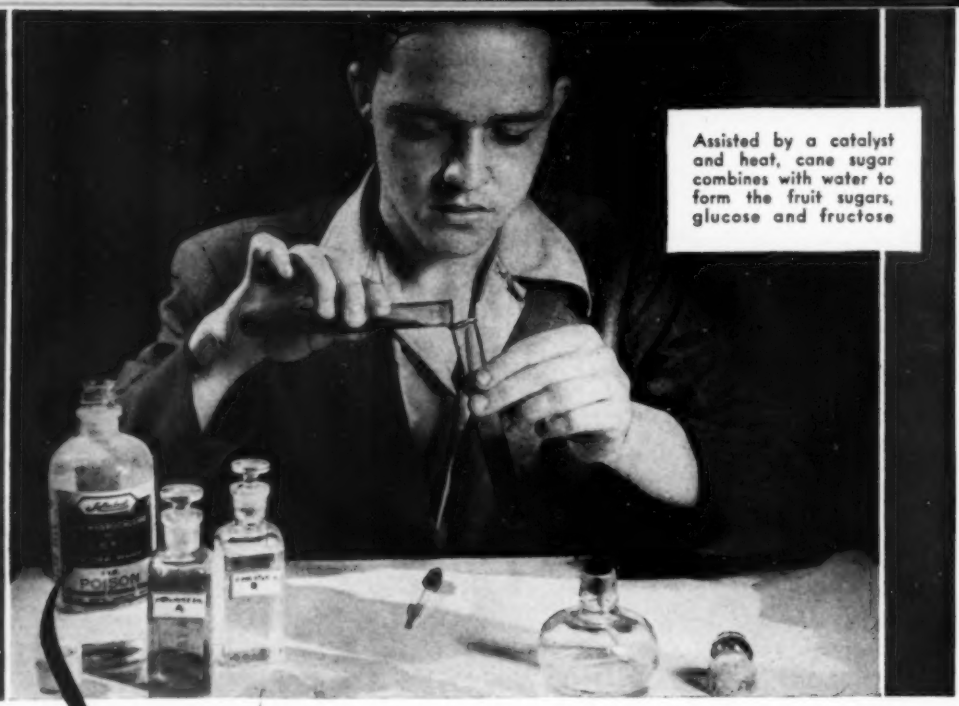
TEMPERATURE AND HEAT. Two objects at the same temperature need not contain the same amount of heat. Provide two similar beakers or glasses, each half filled with water at room temperature. Into one, insert a test tube one-third full of boiling water, and note with a thermometer the maximum rise in temperature. Repeat the experiment in the other beaker, using two thirds of a test tube of boiling water. The higher rise in temperature will show that the increased contents of the test tube contained more heat. So does a large stove, radiator, or furnace.



HOT-WATER HEATING SYSTEM. Any amateur in glass bending can set up the working model above. The lower bent tube above the burner represents the heating boiler; the thistle tube at right, the expansion tank; and the zigzag tube at center, one of the radiators. Fill the model system with water, and apply gentle heat from the burner. Moving air bubbles will then trace the flow of hot water. It rises in the pipe above the flame, descends into the "radiator," and returns, partly cooled, to the lower connection of the boiler.

WARM-AIR HEATING SYSTEM. To make this model, a coffee can and another set within it form the "furnace" shown in the diagram. Hot and cold air ducts may be made of mailing tubes fastened with sealing wax. Two cardboard "rooms" with a wrapping-film front, and a stick of burning incense, reveal what happens. Warmed air rises into the rooms and returns to the furnace.





Assisted by a catalyst and heat, cane sugar combines with water to form the fruit sugars, glucose and fructose

SUGAR . . . .

VITAL FOOD FOR MEN AND GUNS

SUGAR, front-page news not long ago as America's first war-rationed article, is depended upon to supply concentrated energy to the men at the front and the people at home. It is the raw material for millions of gallons of alcohol, essential in making smokeless powder. So vital is its need, that the Germans are said to be making it from wood.

Struck with this importance, the home chemist may well seek out the chemical composition. Sugar heated in a test tube melts into a clear liquid, then darkens, giving off vapor. Heated long enough, it becomes a black mass and a vapor which condenses into water. Thus it is carbon, hydrogen, and oxygen.

"Simple" sugars have a formula $C_6H_{12}O_6$. Glucose and fructose, sugars in ripe fruit, are simple. "Double" sugars combine two simple sugar molecules with the loss of a molecule of water, $C_{12}H_{22}O_{11}$. Cane, milk, and malt sugars are double. Sucrose, the white substance on your table, decomposes easily into equal parts of glucose and fructose. This occurs partially

Brown sugar is refined by filtering a solution of it through boneblack or powdered charcoal, as at left. Color and some of the taste are absorbed, and the clear liquid product crystallizes into white grains

in making jellies and jams. To demonstrate this change, put sucrose in a test tube containing water and a few drops of hydrochloric acid, and heat almost to boiling. For testing you need a solution known as Fehling's, prepared and stored as two solutions to be mixed in equal parts for use. Solution A consists of 17 gm. copper sulphate crystals in 250 cc. water; solution B, of 87 gm. sodium potassium tartrate (Rochelle salts) and 25 gm. stick sodium hydroxide in 250 cc. water. Mixed, these are clear blue. Pour some of the sucrose solution into a little of the mixed Fehling's solution, and heat. Glucose and fructose will reduce the cupric hydroxide to insoluble cuprous oxide, changing the color to yellow, brown, or brick red. Sucrose will not change the color.

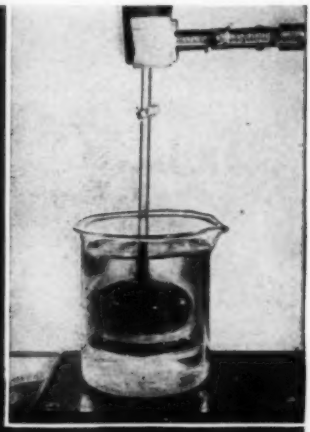
Common sugar is made from sugar cane or sugar beets. The juice is purified and boiled until it thickens. Sugar crystallizes and is separated from the sirup by whirling in a centrifugal machine. The crystals are brown sugar, and the liquor remaining is largely molasses.

Brown sugar may be converted into white in your home lab. Fill a vertical glass tube with boneblack, or powdered charcoal, plugging the bottom with cotton, and pour through it a solution of brown sugar or diluted molasses. If the column is too short, the solution may not lose all its color, but if it is just right, you will get a clear liquid which crystallizes in pure white grains. Refined cane sugar and beet sugar are identical chemically.

For nutritive value, corn sirup and honey are probably better than sugar. Corn sirup is chiefly glucose, which may be assimilated without digestion, while cane sugar must be broken down by the digestive juices. Glu-

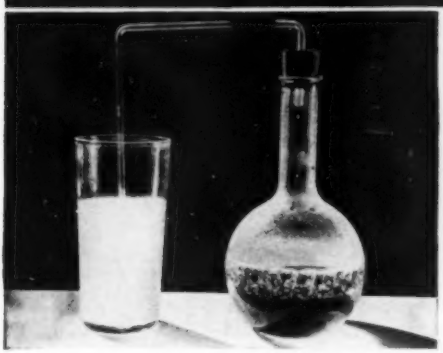
To see what sugar is made of, heat a little in a test tube. It will decompose into its constituents, black carbon and droplets of water, as illustrated at left

Sugar preserves fruits by drawing water out of plant and animal organisms that cause them to spoil. This is demonstrated at the right, where water is drawn through a membrane by a strong sugar solution



Below, a solution of corn sirup is fermenting under the action of yeast. Gas given off turns limewater white, showing it is carbon dioxide

Ethyl alcohol remains in the flask. To prove it, add to a solution of potassium bichromate and sulphuric acid. The solution turns green



Caramel flavoring may be made by heating dry cane sugar carefully to 210 deg. C. Some of the water in the sugar crystals evaporates, leaving an excess of carbon and changing the color and taste

cose, however, is little more than half as sweet as sucrose. Honey is chiefly fructose, wholesome and easily digested. It is the only sugar sweeter than sucrose.

By heating sucrose to 210 deg. C., and constantly stirring, coloring and flavoring caramel is formed. The sugar loses some of its water and retains an excess of carbon.

Sugar sirups preserve foods more by physical than chemical action, killing plant and animal organisms by drawing out their water—a process known as plasmolysis. To show this, tie a nonwaterproof cellulose sheet over a thistle tube, invert the tube, fill to mark with colored water, and suspend in a strong solution of sugar and water. Water in the tube will decrease, passing by osmosis through the cellulose sheet into the sugar solution.

You may make alcohol by dissolving 50 cc. corn sirup or molasses in 400 cc. water in a flask. Mix a quarter of a yeast cake and water into a thin paste, and add to the solution. Connect the flask with a tube leading into a glass of limewater, and set the apparatus in a warm place for two or three days. Carbon dioxide passing through turns the limewater white. Pour a little of the remaining fermented liquid into a test tube containing a solution of potassium bichromate in water and a few drops of concentrated sulphuric acid, and heat gently. Alcohol will turn the solution green.

Cellulose, the chief ingredient of sawdust and cotton, has the formula $(C_6H_{10}O_5)n$. Cooked in water containing an acid, these units are broken apart, and a molecule of water is added to each. The process is called hydrolysis, and the product is sugar.

Dissolve cotton in concentrated sulphuric acid, and pour carefully into a test tube containing five times as much water. Heat in a bath of boiling water for half an hour, remove, and when cool neutralize with a strong solution of sodium carbonate, pouring this in until effervescence stops. Test with Fehling's solution and you will find that you have made sugar.

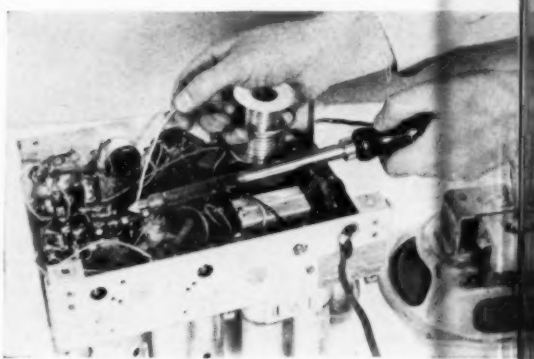
Cotton dissolved in acid and added to water can be converted into sugar by heat. The cellulose units in it, or in wood, break down, each molecule combining with a molecule of water

Radio Ideas

AUTOMATIC AIR-RAID WARNINGS are sounded by this attachment which may be connected to any radio receiver without interference with program reception during normal use. A switch keeps the device on guard when the radio is turned off. It is kept turned to a 24-hour "alert" station, and its warning note will awaken sleepers.

NONMETALLIC SHIELDING, in place of the usual tin containers and metal partitions, can be painted directly on radio tubes, as shown above, by using a mixture of one level teaspoon of powdered graphite and two of collodion, an ordinary drug-store item. Two or three coats are necessary, and a ground connection should be made by looping a wire around the tube. The mixture may be used on cardboard containers and partitions if thinned with a third spoonful of collodion.

SOLDERING WITHOUT TIN is possible with the development of a new bismuth-lead alloy now available in the wire form shown below and in rods and bars. A slightly higher temperature is required to melt it, but it flows freely, makes sound joints, and is said to have more resistance to atmospheric corrosion than the old lead-tin alloys. It works well on steel, tin plate, galvanized iron, copper, brass, and zinc.



GROOVES IN PHONOGRAPH RECORDS may be examined minutely for quality and depth with the aid of the handy little low-power microscope in the photo at the right. The condition of needle points also may be checked with its help. Focus is adjustable, and the gadget has a magnifying power of 15 diameters, ample for the use for which it is intended. It is equipped with a self-contained No. 1 flashlight battery and bulb to illuminate the surface of the record. The battery may be seen in the photo jutting out slightly at one end of the magnifier. Felt "feet" are placed on the underside to assist the device in sliding easily over the record's face. The unit is light in weight, has a black wrinkle finish, and comes with complete instructions.

COMBINATION RADIO RECEIVER AND AMPLIFIER

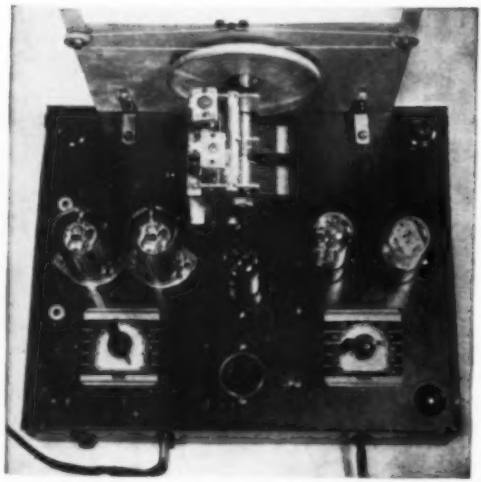
• • •

By ARTHUR C. MILLER

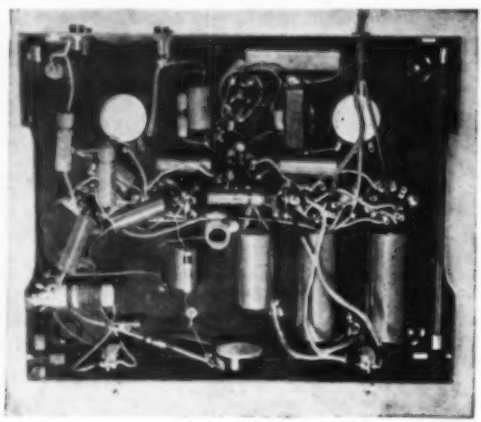
USING an inverted metal letter holder, found in most stationery stores, instead of the usual steel radio chassis, this instrument combines into one unit a TRF broadcast receiver and high fidelity P.A. amplifier. By an unusual circuit arrangement all five tubes are in operation when the instrument is in use either as a radio receiver or as a Public Address amplifier, that is, the radio frequency stage and detector stage double as the first two stages of the P.A. amplifier.

An analysis of the circuit shows at once that no power transformer is employed. The circuit is operated only on straight AC current. In spite of the lack of a power transformer, the output from the rectifier circuit is still higher than the line—200 volts to be exact—and the maximum power output of the 25L6-GT/G tube, about 5 watts, can be obtained. The high plate voltage is obtained by using a voltage doubler circuit with two 35Z5-GT/G's.

When the upper feed line in the diagram is positive, current flows through the lower tube and the 30 mfd. condenser and charges the condenser. When the reverse condition occurs on the other half of the cycle, the power line lead to the cathode is positive and no current can then



Top and bottom views of the receiver and amplifier. The condenser is raised to be in line with the center of the dial. In the tube bank, those unshielded are 35Z5-GT/G's. The unshielded coils are shown below



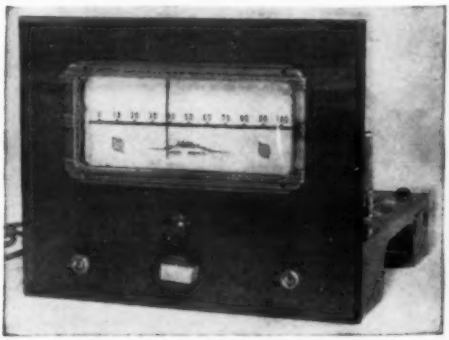
LIST OF PARTS

Metal letter holder.
Dial, 8". Octal sockets (5).
Socket and plug, 4-prong.
Electrodynamic speaker, 6", field 450-500 watts.
Output transformer, 2,000 ohms.
Toggle switches: S.P.S.T. on-off, S.P.D.T. radio-phono.
Volume control (2): 250,000 ohms, 750,000 ohms.
Tone control, 50,000 ohms.
Coils, unshielded: RF, antenna.
Tubes: (2) pentode-triode 12B8-GT; beam power 25L6-GT/G; (2) half-wave rectifier 35Z5-GT/G.
Condensers: Tuning, 2-gang. Paper tubular, 400 volts, (3) .05 mfd., (2) .06 mfd., (3) .1 mfd. Electrolytic, 50 volts, 5 mfd., (2) 10 mfd.; 250 volts, 12 mfd.; (2) 450 volts, 30 mfd.
Resistors: Carbon, ½ watt, 3,000 ohms, 125,000 ohms, 150,000 ohms, 200,000 ohms, 400,000 ohms, (2) 750,000 ohms, 1.5 megohms; 1 watt, 8,000 ohms, 30,000 ohms; 2 watts, 600 ohms. Line-cord, 140 ohms. Wire-wound, 10 watts, 2,000 ohms.

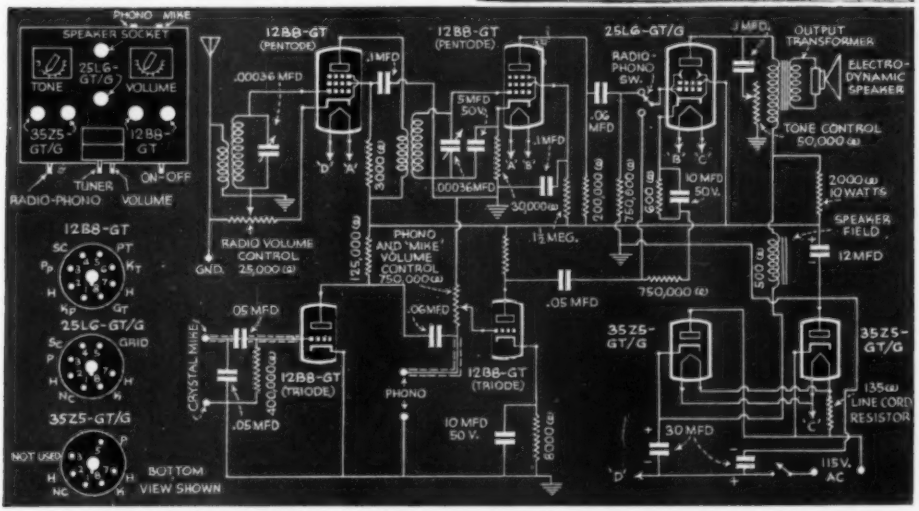
flow through this tube. The plate of the other tube, however, is also positive and can now operate and permit current flow to charge the upper condenser. Since the two condensers are connected in series and are charged 60 times a second, the useful voltage delivered to the speaker-field choke and filter condenser is equal to twice the power line voltage.

Tracing the wiring diagram further and beginning with the antenna circuit, you will notice that the pentode section of one 12B8-GT tube is used as an RF amplifier, which is a transformer coupled to the pentode section of another 12B8-GT acting as a biased detector. The triode portion of the first 12B8-GT is employed as a pre-amplifier stage, while the triode portion of the second 12B8-GT becomes the second stage of the five-tube amplifier. Pick-up connections are made into this stage. The output from the two 12B8-GT's is fed into the 25L6-GT/G power amplifier, a switching arrangement in the grid circuit connecting either the pentode stages (radio) or the triode stages (P.A. amplifier).

No radio cabinet is shown for this receiver—nothing but a polished front panel—as it was felt that the reader might like to try his hand at designing his own cabinet, especially if he is proficient in woodworking. If time is important and there is an old radio console handy, the chassis can just as well be slipped into that cabinet.



Volume control is below the tuning knob at the center of the front panel. In the rear view at the right, the speaker leads are shown plugged in



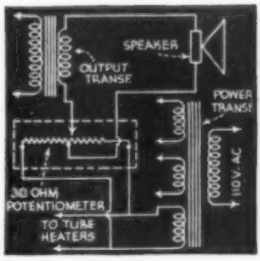
Complete wiring diagram showing in detail the connections for the radio receiver and P. A. amplifier. Left, above, a sketch showing the layout of the parts, and left, below, a base layout for the tubes

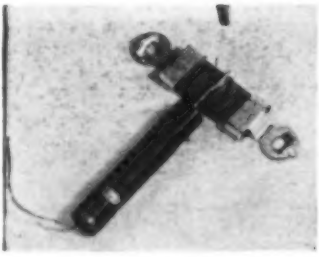
Servicing Your Radio—PART 7

SOME of the most annoying experiences with old-model receivers or new models that have been in use for some time are caused by humming. This can be traced to several sources, most of them within the scope of the amateur repair man. Among the most frequent are hum in the phonograph of a combination set or in an older-type electrodynamic speaker, or that caused by a broken filament resistor, weak or gassy tube, or faulty electrolytic condenser. The pictures below illustrate the cures.

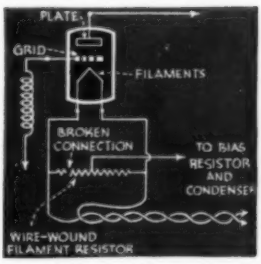
WHEN the hum occurs in the speaker only when the phonograph is being used, ground the pick-up arm and motor frame to the radio chassis, both leads from the pick-up being grounded with braided shield covering. If the hum persists, a 1/16" metal plate, 8" to 12" in diameter, will act as a magnetic shield if screwed to the motor board between the motor and turntable.

SHOULD an old-type electrodynamic speaker lack a "hum-bucking" winding on the voice coil, connect a 30-ohm, 10-watt, center-tapped potentiometer across the power transformer's 2.5-volt or 6.3-volt heater winding in series with the voice-coil winding. A short, soldered wire serves as a center tap.





FILAMENT resistors, used in earlier models before indirectly heated tubes were perfected, must be replaced if they are broken. They are connected across the filaments of RF and other tubes to supply grid bias current and balance out hum from the power transformer's AC filament winding.



Often hum can be corrected by replacing a weak or gassy rectifier tube. If hum increases after the set has been on for a while, a power tube may be at fault, especially an old 47 power pentode tube

Electrolytic condensers go bad for many reasons—they may have open or short circuits, or the wet type may dry out and lose effective capacity. In any case, the best bet is to get a new condenser

CHAMPION SPARK PLUGS

A vast army of volunteer workers are enlisted under the Red Cross, Civilian Defense and other service organizations, eager to play their vital part in time of emergency. Reliable transportation is an essential part of their activities. Champion Spark Plugs are playing their vital part by providing dependable ignition in the motorized equipment of these organizations as well as that of all branches of the armed services.

Check your spark plugs! Check them as a patriotic duty, and a personal, self service. When spark plugs are tested, cleaned and adjusted at regular intervals, they will remain economical and efficient throughout their useful life—and you will know when new ones are needed. Old, worn-out or inferior quality spark plugs can be exceedingly wasteful, and inefficient.

Champion Spark Plugs have won world recognition for better performance, due directly to many exclusive and patented features. One of these, which means most to motorists today, is the patented Sillment seal which banishes troublesome leakage, *common to ordinary spark plugs.* This exclusive feature prevents overheating, and pre-ignition, a cause of rough, wasteful engine operation.

TO SAVE GASOLINE • KEEP YOUR SPARK PLUGS CLEAN

WHAT TO DO ABOUT

1 IF YOU SAVED YOUR LAST WINTER'S ANTI-FREEZE...

Some of the ingredients of "Prestone" anti-freeze will last from one winter through the next—those, for example, which protect the car against freeze-up. But to give protection against freeze-up is only one function of a good anti-freeze. A good anti-freeze also performs other functions, just as important. One of these is to guard against rust and corrosion... which is why all good anti-freezes are "inhibited." These inhibitors do wear out; and when that happens the car is no longer protected against clogging and overheating caused by rust.

That is one of the reasons why you cannot use an anti-freeze indefinitely... why, for instance, we guarantee "Prestone" anti-freeze for "a full winter's use," and no more. *New, fresh anti-freeze is always to be preferred over anti-freeze which has gone beyond a single winter's driving.*

If, however, you decide to re-use your anti-freeze, take the following precautions:

If you stored your anti-freeze during the summer, take it to your dealer *before* putting it back in the car. There are 2 good reasons.

A *To make sure that no dirt or foreign matter has spoiled it.* (Cans frequently rust through from the outside and from the bottom. Dirt and foreign matter will clog your cooling system badly.) If your solution is brown or rusty-looking, don't bother to take it to your dealer but discard it at once. Be extremely cautious in this regard. Your car is a valuable property: it is in the interest of sound conservation to take all reasonable precautions.

B *To have the strength checked*... You don't know, definitely, what concentration you had at the end of the season. If your anti-freeze was "alcohol base," you almost certainly lost strength before you took it out last spring. Even if you used "Prestone" anti-freeze, which contains no boil-away alcohol, have the strength checked just the same. You may have lost protection through careless filling, slop-over at the over-flow pipe, and leaks caused by road-shock and wear-and-tear during driving.

if you left your anti-freeze in your car, and have been driving with it all through the summer, point B (above) is even more important, for obvious reasons.

These precautions are the very least you can take to protect your car. Remember, none of them will put back into the anti-freeze the rust and corrosion inhibitors which were there when you bought it last fall, and which have since been used up. This is one of the sound technical reasons why manufacturers guarantee anti-freeze for only one winter's driving.

ANTI-FREEZE THIS FALL

2 IF YOU DID NOT SAVE YOUR LAST WINTER'S ANTI-FREEZE...

See your dealer at once and get "Prestone" anti-freeze installed in your car. As of the date this advertisement goes to press (approximately July 15th) it appears that there will be enough "Prestone" anti-freeze this fall—after Army, Navy and lend-lease requirements have been met—to supply all regular users. We make this prediction because we have increased our manufacturing facilities and because there will be fewer cars on the road this coming winter.

HAVE YOUR DEALER CHECK YOUR CAR for leaks, rust, sediment, or loose connections which may have developed during summer driving. Make sure your "Prestone" anti-freeze is used in a clean, tight cooling system. Then you can *forget* the anti-freeze problem for the rest of the winter. You will be protected completely—against freeze-up, boil-away, dangerous and obnoxious fumes, rust and corrosion. You can place complete confidence in new, fresh, full-strength "Prestone" anti-freeze. It is *guaranteed* for one full winter season.

Product of NATIONAL CARBON COMPANY, INC.
Unit of Union Carbide and Carbon Corporation

UCC

General Offices: New York, N. Y.
Branches: Chicago and San Francisco

The words "Eveready" and "Prestone" are registered trademarks of National Carbon Company, Inc.

O.P.A. RETAIL CEILING PRICE $2.65 A GAL.

PRESTONE
TRADE-MARK
ANTI-FREEZE

YOU'RE SAFE AND YOU KNOW IT
...ONE SHOT LASTS ALL WINTER!

IT'S THE SAME "PRESTONE" ANTI-FREEZE, no matter which container it comes in—metal can or glass jug. To conserve metals for wartime use, the familiar "Prestone" anti-freeze can was discontinued early this season, and the sturdy new glass jug was substituted. Your dealer may have cans or jugs or both. Buy either. No difference in the "Prestone" anti-freeze they contain.

..until Victory!

WHILE the mammoth Western plants are serving the Stars and Stripes—working night and day producing millions of military cartridges—the names SUPER-X, XPERT, SILVERTIP and SUPER-MATCH remain symbols of outstanding service to the shooters of America.

All of the ingenuity of the now greatly augmented Western technical staff, which developed this famous line of World Champion Ammunition, is focused on giving our fighters the benefits of its skill and long experience.

Western ammunition—and our entire facilities—yes, and the many thousands of loyal Western workers—are proudly in the service of Uncle Sam...until Victory!

WESTERN CARTRIDGE COMPANY
East Alton, Ill.

Western
WORLD CHAMPION AMMUNITION

MORE MARKSMEN FOR AMERICA

Trouble Comes Double

(Continued from page 147)

about it—and when I got in and stepped on the starter the motor ran all right.

"Next day, when I was on that grade crossing out on the dirt road over east of here, the same danged thing happened. This time a feller came along in a truck and pushed me off the tracks and down the road to a little hick garage. The feller there said I had a short in my terminal box, and he'd fix it. Since then the motor's been missing pretty bad, but it ain't laid down on me, and until jest now I'd plumb forgot about the new rotor the first feller said I should get. You better put one in."

Gus took off the distributor cap and examined the rotor. "Yes, you need a new one," he said. "But the rotor isn't what stalled your engine when you hit those bumps in the road. Where was that soldering job that first mechanic did for you? I don't see any signs of it—yes, here's where it *was*." He grinned. "Did you try any of your tricks on that fellow?"

"Tricks?" Osgood said. "Well, I did give him a seegar. It made him sort of sore."

"*Maybe* it was just chance," Gus said. "That drop of solder got down into the distributor, and when you hit those rough spots it jounced around and shorted your juice. Then when you turned off the switch it dropped back out of the way."

"If he did that on purpose it was a mighty dirty trick!" Osgood said virtuously. "Tell you what let's do, Gus. You put that wheel back on so as I can get home to supper, and tomorrow morning I'll bring my car in and you can fix her."

Gus heard a familiar voice out at the gas pump. He took Osgood by the arm and led him to the shop door. State Trooper Jerry Corcoran was filling his motorcycle's gas tank. "See that cop, you public menace?" Gus said. "Well, I'll put that wheel back on if you say so, but if you drive that jallopy of yours out of here before those brakes are fixed, before you have gone three blocks that cop will stop you and inspect them, and you'll lose your license sure as the Good Lord made little green apples!"

Osgood looked at Gus and saw that he wasn't joking. "Oh, all right," he said. "I'll leave the car here—but how am I going to get home? It's a good three miles from here. Can I get a taxi?"

"Not under an hour—this time of day. You can walk. It's tough," Gus said without sympathy. "But you know what I told you—trouble comes double!"

WITTE IS ALL-OUT FOR VICTORY WITH 100% WAR PRODUCTION

• *Diesel Engine Assembly Line in the WITTE factory*

WITTE DIESEL ENGINES and DIESELECTRIC PLANTS

WITTE Diesel Engines and Diesel Electric Plants are available for the defense needs or war efforts of all United Nations.

WITTE Diesel Engines and Dieselectric Plants are out on the victory front . . . serving America and her allied nations all over the world . . . aiding the war effort.

Today, the war needs of the United Nations come first at the large WITTE factory. **We are 100% in war production!** Every piece of modern machinery and every skilled Diesel engineer in this busy plant is devoted to freedom's cause. WITTE has been serving America and other leading nations for 73 years . . . will continue to serve the Democratic world in war and peace.

After victory, our increased production facilities, skilled personnel and improved engineering developments will bring you even better WITTE Dieselectric Plants—ready to produce extra power at lower cost.

A WITTE Diesel is worth waiting for . . .

WITTE ENGINE WORKS

LARGEST BUILDERS OF SMALL DIESELS

2228 OAKLAND AVE., KANSAS CITY, MISSOURI, U.S.A.—Cable Address: "WITTEKCMO"

A dull tool is a shirker on any job—but it is doubly at fault when its work is war-essential. Making things last longer on the home fronts—building or repairing needed buildings and equipment—training in the important wood-working arts . . . millions of jobs call for *keen saws.*

Nicholson makes all kinds of files for keeping saws sharp. For filing hand-saws, Nicholson offers a helpful folder on

"HOW TO SHARPEN A SAW"

FREE to carpenters, mechanics, woodworkers, farmers, industrial arts students. Simply mail us your request (a post-card will do) for this interesting saw-filing instruction sheet.

NICHOLSON FILE CO., 22 ACORN STREET
Providence, R. I., U. S. A.
(In Canada, send your request for instruction sheet to Nicholson File Co., Port Hope, Ont.)

• For your needs in Nicholson or Black Diamond Slim Taper Saw (and utility) Files, see your hardware or mill-supply house. Many stores have these famous files on view in this counter display.
NICHOLSON
SAW FILES
SHARPEN YOUR SAWS
Easily and Quickly

NICHOLSON FILES *FOR EVERY PURPOSE* NICHOLSON U.S.A. MADE IN U.S.A.

Inside Facts About Ciphers

(Continued from page 89)

under it is coded from the Y alphabet. Other multiple-alphabet ciphers are variations of this principle. The receiver of such a cipher writes the keyword repeatedly under the coded message, and reverses the process of coding. Both coding and decoding are usually done with slides or disks, though they are not essential. These multiple-alphabet ciphers were long considered "indecipherable."

In wartime, "cipher crackers" or cryptanalysts have more than their share of headaches trying to make sense out of cryptic messages that come into their hands.

The enemy doesn't label the message to show what kind of cipher has been used. It is one thing to solve a cipher when the system used is known, and another to find out the system. The frequency of words, letters, two and three-letter combinations (digraphs and trigraphs), prefixes, suffixes, initial letters, terminal letters, and other statistics have been compiled and studied. They differ according to language and also according to their source in the same language. In wartime, military words and expressions would be the best source. For ordinary English, the frequency of the letters of the alphabet is in the following order: ETOANIRSH-DLUCMPFYWGBVKJXZQ. Vowels (AEIOUY) are about 40% of the number of letters used: The five letters ETOAN are about 45%; The nine letters ETOANIRSH are about 70%; the high-frequency consonants about 30%. These percentages help in finding out what kind of a cipher it is, as well as for solving it after the system is discovered. A percentage that is correct for normal English but applies to such letters as Q B X Z etc. indicates substitution; if correct for the actual letters, transposition; if very irregular it indicates some other system.

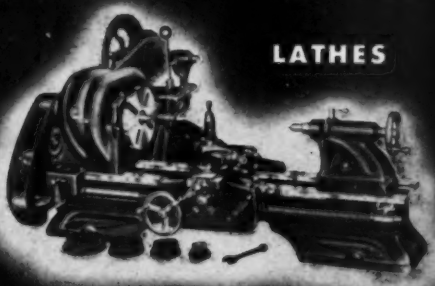
The use of codes as distinguished from ciphers is apt to stump even the most expert "cipher crackers." When a spy goes out on a job he will arrange with his intelligence department to use a certain book as the key to his cryptic reports. His cryptogram might read "55-2-7-11" which, if he used the July P.S.M. as his key, would guide his correspondent to the second column on page 55, lines 7 to 11: "The square infantry division (four regiments) is supported by a field artillery brigade of three regiments which carry 48 105-mm. howitzers and 24 155-mm. howitzers." As there are millions of books and magazines in the world, it is almost impossible to trace the publication even though a cryptanalyst knows perfectly

(Continued on page 224)

KEEP 'EM FLYING

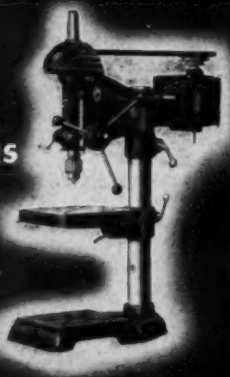
BUY WAR BONDS

Atlas MODERN SHOP EQUIPMENT

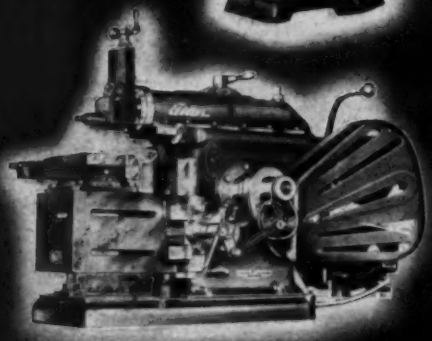


LATHES

DRILL PRESSES



MILLING MACHINES



SHAPERS

HISTORY is being made today by American industry. Every industrial craftsman can take pride in the weapons he helps produce. They are the best in the world! Here at Atlas we are glad of our opportunity for service — making the tools for building so many of Uncle Sam's effective war machines. Planes, ships, tanks, guns — in nearly all industrial plants on the honor rolls of the nation you will find one or more Atlas Machines helping speed production. Someday, again, you will be buying machine tools for your shop. Then, you can be sure that our experience in meeting today's intensive demands, will make Atlas Equipment better than ever. Atlas Press Company, 1155 N. Pitcher St., Kalamazoo, Michigan.

VICTORY FIRST! - THEN Atlas TOOLS FOR YOU

How to polish metal in a lathe!

● For a beautiful high finish, just hold a strip of fine grit Aloxite Brand Aluminum Oxide Cloth against a piece of steel that has been given a finishing cut on a lathe. Other uses for this cloth in metal work include removal of rust, polishing metal rods held in a drill press chuck, removing small amounts of metal in fitting parts, and cleaning preparatory to soldering or brazing.

Lapping a giant crankshaft!

● The same Aloxite Brand Cloth shown above is being used here in a fixture to lap the main bearing surfaces of a giant crankshaft as it turns on a lathe. Aloxite Brand Cloth is available in sheets and rolls. Send us 10¢ for helpful 95-page illustrated manual on home craftsmanship, and we'll include a souvenir sharpening stone too.

CARBORUNDUM
ABRASIVE PRODUCTS

Write Dept. S-112

THE CARBORUNDUM COMPANY
REG. U. S. PAT. OFF.
Niagara Falls, N. Y.

Carborundum and Aloxite are registered trade-marks of and indicate manufacture by The Carborundum Company

Inside Facts About Ciphers

(Continued from page 222)

well what kind of a cryptogram it is. Sometimes spies will make it harder by having a previous arrangement to change the publication each week or month.

Numerous machines have been invented for enciphering messages mechanically, but it was not until 1934 that any inventor devised a small cryptograph machine that actually met the requirements of a large military body. In that year the French General Staff ordered a portable cryptograph machine that could be operated by one person.

A Swedish inventor named Boris Hagelin had the most compact and workable machine of that time. It weighed about 40 pounds and was capable of operating at a speed of nearly 200 characters a minute. To meet the requirements of the French General Staff, Hagelin modified his machine so that it was much smaller, more compact, and nearly foolproof.

At present, there are two models of this machine being manufactured. One, known as the C-38, is a small hand-operated machine measuring 3¼ by 5½ by 7 inches. The second machine is slightly larger, can be operated by an electric motor, and is known as the BC-38.

In the field, a soldier can carry the portable machine by a strap which fits over his shoulder. When he is ready to send a message, he sets the "key numbers" according to prearrangement. This is done by means of a setting wheel located at the left of the machine. Next, he selects the letters of his text, one after the other, against the letters found on the setting wheel. After each setting, he pulls a handle at the right of the machine, which automatically prints the cipher character on a paper tape. Deciphering the message is a simple matter if the recipient knows the key used by the sender. He merely throws a switch on his machine, which prints the ciphers in clear text.

Ciphers used by the Hagelin cryptographers are of the double-substitution type which means that any letter in the clear text alphabet, can be used in cipher by any other letter in a varied sequence. Thus, the letter "T" could be enciphered by any of the 26 letters of the alphabet in any varied sequence. It has been said by experts that the theoretical length of the substitution series for the Hagelin Cryptographers is over 100 million letters. All the countries in the world could use the same machine and still be comparatively secure against having their cryptic messages deciphered.

A Suggestion to the Millions of .22 cal. Rifle Owners

SHARE YOUR RIFLE WITH YOUR NEIGHBOR

HELP MAKE AMERICA NOW, AS IN THE PAST, A NATION OF MARKSMEN

Right now, more thousands than ever want a Mossberg .22—the military type sporting rifle—because in these stirring times they feel the natural American urge to have and use a gun.

We cannot supply that demand. Our efforts and facilities are 100% on War Production.

So we respectfully make this suggestion to owners of 22 cal. rifles *of all makes*—"Share your rifle with your neighbor. Explain the rules of safety. Show him how to handle and operate a rifle, how to "draw a bead" on the target. Let him experience the thrill of shooting. Use ammunition sparingly, and share the expense. You'll be making a real contribution to the war effort . . . for a nation of marksmen is unconquerable!"

To every owner who agrees to share his rifle—regardless of the make of the rifle—we will send, absolutely free, an authoritative, illustrated booklet "The Guidebook to Rifle Marksmanship," prepared by the National Rifle Association of America—a book every shooter will want.

JOIN A GUN CLUB, OR START YOUR OWN

The National Rifle Association Cooperates

To every owner of a gun and to every patriot—another suggestion. Right now is the time to apply for membership in the Rifle or Gun Club in your community. You'll find the members are the nicest, friendliest folks in town. And, though small arms ammunition may be scarce, reasonable quantities are available to such recognized clubs. Or, start your own shooting club. We will be glad to supply free, through The National Rifle Association, a helpful and interesting book on how to establish and conduct such a club.

O. F. Mossberg and Sons, Inc. 29711 St. John St., New Haven, Conn. *Check booklets desired*

Sirs: I agree to "Share my .22 cal. rifle" and will invite a neighbor to shoot with me. Please send my copy of "The Guidebook to Rifle Marksmanship." ☐

Please send me the N. R. A. booklet on how to organize and conduct a shooting club ☐

Please put my name on your list to receive the Victory Catalogue of *postwar* Mossbergs as soon as possible after the war is won ☐

Name _____

PLEASE PRINT

Street _____

City _____ *State* _____

O. F. Mossberg and Sons INC.

Manufacturers, in normal times, of

.22 cal. RIFLES • SHOTGUNS • TELESCOPE SIGHTS TARGO GUNS and Equipment

ATKINS

SILVER ★ STEEL

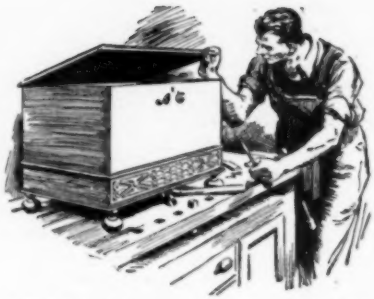
Saws and Trained Men are VITAL TO THE VICTORY PROGRAM

If ever there was need for trained men—and for the kind of tools that help men put their skills to fullest use—that time is now. Precision-made Atkins Saws have what it takes, not only to do a job fast, but to do it right. Whether you use saws in your work . . . in your home workshop . . . or to make necessary repairs around the house . . . you'll find it greatly worth your while to insist on the famous Atkins brand. Ask your hardware dealer to show you Atkins Saws.

Send 10c for How-To-Do-It Book

E. C. ATKINS AND COMPANY
428 S. Illinois St. • Indianapolis, Ind.

SAWS



Early Colonial pine chest, plan 308A, 25¢

Save Money and War Materials by Making Christmas Gifts

YOUR own handiwork is always a gift more personal than any you can buy, but there is more reason now than ever before for making your own Christmas gifts. Not only will you be saving money, but you will be conserving stocks of articles made of critical war materials. Buy and give such articles only if they fill an actual need. For sentimental and other gifts, give things that can't be bought—things you can make from wood and other noncritical materials.

Our tested shop blueprints are a short cut to better craftwork gifts. A few of the projects for which plans are available are listed below. For a complete list, send a stamped, self-addressed envelope.

Auto Ski Rack, Turned Flower Basket, Ornamental Miniature Wheelbarrow, 414A..... $ .25
Combination Boat, 15' hull, for use with sail, outboard motor, or oars, 131-132-133-R..... 1.00
Early American Style End Table, 361A..... .25
Folding Wall Brackets (turned), Treble-Clef Bud Vase (metal or plastic), Vacuum Cleaner Attachment Rack, 408A..... .25
Four-Leaf Card or Occasional Table, 239A..... .25
Gate-Leg Table, 3' 6" diameter, circular top with leaves up, no turning, 24..... .25
Hostess Tray, Modern Book Ends, Machinist's Hammer, Lathe Dog, 412A..... .25
Miniature Fleet of Nine Modern U. S. Fighting Ships (full-size plans and instructions in booklet form), 372-R..... .50
Sectional Rowboat, 9' 8" long; can be used with small outboard, 340-341-R..... .75
Tea Wagon (removable tray and drop leaves) 20" by 30" top (turning), 13..... .25
Tile-Top Tables (wood and metal), 249A..... .25
Utility Rowboat, 13' long; can also be sailed or driven by outboard motor, 224-R..... .50

Popular Science Monthly
353 Fourth Avenue, New York, N. Y.

Send me the blueprint, or blueprints, numbered as follows:

.....

I am inclosing.....dollars.....cents

Name.....

Street.....

City and State.....

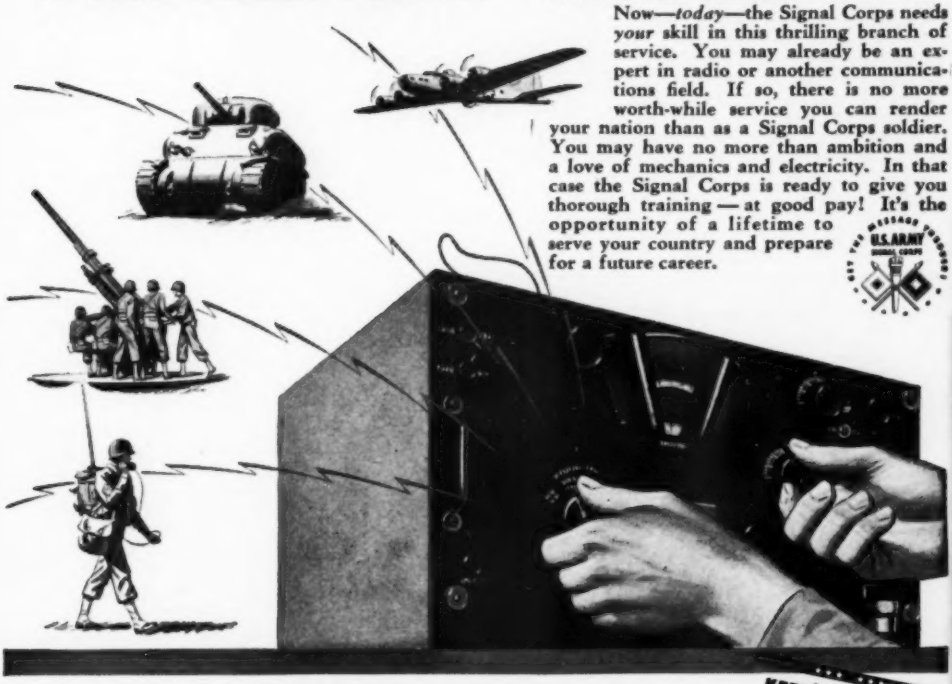
(Please print your name and address very clearly)

The "Nerve Center of the Army" needs your skilled hands TODAY!

This is a war of speed—a radio war. Commands and messages must go through like lightning. Never have communications been so vital to victory, or have new devices meant so much.

The whole responsibility for "getting the message through" is in the hands of the U. S. Army Signal Corps. Hands that install and maintain countless thousands of radio sending and receiving sets — hands that adjust the marvelous mechanisms of America's newest and most secret weapons—hands that flash the orders to attack!

Now—*today*—the Signal Corps needs *your* skill in this thrilling branch of service. You may already be an expert in radio or another communications field. If so, there is no more worth-while service you can render your nation than as a Signal Corps soldier. You may have no more than ambition and a love of mechanics and electricity. In that case the Signal Corps is ready to give you thorough training — at good pay! It's the opportunity of a lifetime to serve your country and prepare for a future career.



HOW YOU CAN GET IN NOW

1. *ENLISTMENT*

If you are 18 to 45 and physically fit, you may apply for enlistment in the Signal Corps or in the Signal Corps Enlisted Reserve.

Direct Enlistment: Experience as a licensed radio operator, a trained radio repairman, a telephone or telegraph worker, will qualify you for active duty at once. From Private's pay you can advance rapidly as you earn higher technical ratings—up to $138 a month, with board, shelter and uniforms.

Enlisted Reserve: If you are skilled with tools but lack qualifying experience, you may enter the Enlisted Reserve. You will be given training, with pay, in one of the many Signal Corps schools, and ordered to active duty when you have completed the course.

Commissions: Graduate Electrical Engineers may apply for immediate commissions in the Signal Corps. And special opportunities for training and commissions are open to Juniors and Seniors in electrical engineering colleges.

2. *CIVILIAN TRAINING*

If you are over 16 years of age, and even though registered for Selective Service, have not received your order to report for induction, the Signal Corps offers you an outstanding opportunity.

If you have ability with tools—if you want to secure training in the vitally important field of communications—you may attend a school in or near your home city. You will be paid not less than $1020 per year *while learning*. And when you have finished your training—in 9 months or less—you can advance to higher pay as your technical skill increases.

Even if you have a minor physical handicap, Signal Corps Civilian Training may give you the chance you've wanted to serve the Army of the United States.

KEEP 'EM FLYING!

U.S. Army

• FOR FURTHER INFORMATION REGARDING ENLISTMENT—Call and talk this over at the nearest Army Recruiting and Induction Station, or write to: "The Commanding General," of the Service Command nearest you.

★

Or write to: Enlisted Branch, AC-1, A.G.O., Washington, D. C.

★

FOR CIVILIAN TRAINING INFORMATION — Call at any office of the U. S. Civil Service or U. S. Employment Bureau.

FOR WARTIME ECONOMY
USE BURD PISTON RINGS

A "Graf-Flox" is not just a plating process . . . it's a treatment of the metal itself.

B "Graf-Flox" rings eliminate the run-in period. Friction is cut to a fraction . . . fuel saved . . . pep and power added.

C "Graf-Flox" guards against scuffing, scoring and seizing.

Motorists know that it is poor economy, even unpatriotic, to permit worn out piston rings to waste gas and oil. That's why car owners are having their motors rebuilt with Burd "Graf-Flox" Piston Rings. These revolutionary rings are self-lubricating to prevent scoring, sticking and seizing. They are self-seating, require no "run-in" period, no delay in hitting the road. Install Burd "Kure-Slap" Piston Expanders and Burd Valve Packing too. For real wartime economy —"Rebuild with Burd!"

BURD
"Graf-Flox"
PISTON RINGS

Burd Piston Ring Co.
Rockford, Ill.

COUPON BRINGS HANDBOOK FREE

BURD PISTON RING CO., Dept. 112-E, Rockford, Ill.

Please send Folder on BURD "Graf-Flox" Piston Rings and a copy of the Automotive Serviceman's "Handy Handbook."

NAME.....

ADDRESS.....

CITY..... STATE.....

U.S. ARMY MOVES WITH HULL COMPASSES

★HULL STREAMLINE COMPASSES assure the right direction of travel for the U. S. Army. Known by America's motorists as the modern means to efficient, direction-wise driving. ★Only available to public so far as dealer stocks permit.

HULL MANUFACTURING CO., P.O. BOX 248-E11, WARREN, OHIO

DRAFTSMEN A Slide Rule For Only 50c. A, B, CI, C, D & K Scales. All American made. Multiplies, dividers, solves square and cube root problems instantly. 32-page Instruction Book included free. Rush 50c today. War stamps accepted. (50c money order only from Canada.)

FRANKLIN PRODUCTS CO.
260-LA Maple Grove Ave., Fort Wayne, Ind.

DRILL PRESS OWNERS!

HERE'S 1 TOOL WITH 5 DISTINCT USES

THE BARRON MULTI-PURPOSE ROTARY WOOD PLANER

PLANES & SURFACES • PANELS & BEADS
ROUTS & GROOVES • RABBETS • TENONS

$7.50 COMPLETE

Converts ANY drill press into a time saving, low cost planer, paneler, tenoner. Surfaces finishes all types of tough grained and knotty surfaces to agate smoothness. Safe! Guaranteed harmless to drill press. Thousands now in use. SOLD ON MONEY BACK GUARANTEE. Full refund on 5 day trial. Shipped prepaid on receipt of $7.50—or C.O.D. YOU RISK NOTHING. Free literature.

STEEL TOP AUXILIARY DRILL PRESS TABLE

Has 200 sq. in. smooth working surface. Equipped for shaper and many other important workshop uses—a real buy at **$5.95**

BARRON TOOL CO., INC.
370 Architects Bldg., Detroit, Mich.

Kit E
Battleship "Texas"

Kits Simplify Building of Model War Vessels

• • •

MODELS of fighting ships pack a real punch of interest these days when the United States Navy is in action in many parts of the world. If you like to build ship models—and there is no finer hobby—you may want to add one or more war vessels to your collection. POPULAR SCIENCE offers construction kits for a battleship, a simplified destroyer, a mosquito boat, and a Canadian corvette. The battleship, shown above, is scaled 1/16" to 1' and is 3' long. It can be built with our kit No. E ($7.95*). The other kits are described below.

For an illustrated leaflet of all our kits, send a stamped, self-addressed envelope.

9M.	U. S. destroyer, Mayo class, 12¾" long, (finished capstan and anchors)	$1.00
8S.	Fishing schooner BLUENOSE, 17½" hull, scale, ⅛" equals 1'. Kit includes anchors, wheel, bell, flags, mast rings	5.30†
9S.	New Bedford whaleboat, with complete equipment, 14" long, scale, ½" equals 1'	2.95†
11S.	Revenue Marine cutter JOE LANE, a topsail schooner, 13½" hull, 21" overall. Kit includes materials and finished fittings	8.00*
13S.	Motor torpedo boat P.T. 10; a 13" exhibition model; shaped hull, propellers, etc.	5.00†
16S.	Canadian corvette, 20" long, scale ¼" equals 1'. Kit includes bell, bitts, chocks, guns, and other fittings	6.75†
7.	Whittling kit with two blocks for making sea captain 5½" high	1.60
8.	Whittling kit for six different Scotties; each is 2" by 2¼" sawed to shape	1.10

Note: If you live west of the Mississippi River, add 50 cents to prices marked with an asterisk (*) and 25 cents to prices marked with a dagger (†).

Popular Science Monthly, Dept. 112A
353 Fourth Avenue, New York, N. Y.

Please send me Kit.....for which I inclose $.....(or send C.O.D. ☐)

Name.....

Address.....

City.....State.....

(Please print your name and address very clearly)

You save the C.O.D. charge by sending your remittance with this order. Remit by money order, check, or registered mail. This offer is made only in the United States. Also see note above.

The War's End

(Continued from page 72)

have proved easy to handle and completely permanent, requiring no maintenance.

The familiar aluminum streamlined trains may be joined after the war by bright aluminum freight cars, while new ships are likely to have aluminum lifeboats as well as sheet aluminum replacing steel in the superstructure to save weight. Other regular uses will range from beer barrels (they don't have to be lined with pitch) to artists' etching plates (they will make more clear prints than copper-plate).

The subject of plastics is so big in itself that it could easily run away with any discussion of the technological future. Its engineers just say that we are entering the Plastics Era and let it go at that. Your entire house—walls, woodwork, stairs, doorknobs, and almost everything else—could be built of plastics. And so could ships, trains, and airplanes. The only limiting factors are the existing methods of shaping the material, and its cost as compared with that of competitive building materials.

This material also has had to fight its way against the handicap of custom—it is notable that plastics have found their quickest acceptance in such new and changing fields as radio, automobiles, and electricity. The first car you buy after the war is over may not have that all-plastic body, but it probably will have 200 or more separate parts made of plastics, ranging from the clock face to the timing gear.

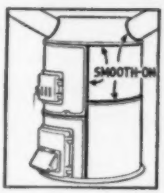
Plastics, too, will contribute their lightness and strength to the enrichment of life in the future. War and the lack of traditional materials already have stimulated their use—so much so that some plastics are running short now.

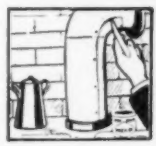
In the wide field of synthetic products the most celebrated unquestionably are synthetic rubber and the silk substitutes, rayon and nylon. These are destined for ever-wider use in the future, and two of them will be used in combination.

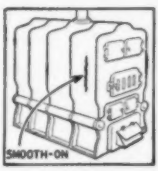
When you are able to buy tires again it is a pretty good bet that they will be made with American synthetic rubber tread and casings, and American rayon cord for fabric. Moreover, they ought to be the best tires you ever had, by far. The great superiority of rayon cord was known before the war, when it was used experimentally in the tires of heavy trucks. It possesses greater strength than any other fabric, and holds this strength under the high heat of heavy-duty driving.

(Continued on page 230)

HOW TO ... Save Fuel THIS WINTER WITH SMOOTH-ON







Air leaks . . . below or above the furnace, or in the flue . . . are a frequent cause of fuel waste.

Stop these leaks . . . reduce your fuel bills . . . help to conserve fuel . . . by one application of SMOOTH-ON . . . easily and quickly, without dismantling any parts. The expansive property of SMOOTH-ON tightly fills all openings and makes an iron-hard seal which is not loosened by expansion or contraction.

SMOOTH-ON is equally effective for stopping leaks of steam, water or air due to cracks in boilers, heaters, pumps or piping . . . makes low-cost lasting repairs of equipment that you cannot replace because of war-time conditions.

This many-purpose iron repair cement also stops leaks in automobile radiators or engine cylinders, and tightens loose fixtures, tool handles and hardware. Be sure to buy a can today and be prepared for repair emergencies.

Buy Smooth-On in 3¼-oz., 7-oz., or larger cans from your hardware store or if necessary from us.

SMOOTH-ON USERS!

Write us how YOU have used Smooth-On to repair your plant equipment, so that we can tell others about your experiences. Your cooperation will help to save much-needed metal and parts, thereby aiding the Nation's war effort. WRITE TODAY.

FREE BOOK

MAIL IT TODAY

Get your copy of our latest 40 page illustrated handbook. Shows how to make repairs quickly, economically. Just send the coupon.

Smooth-On Manufacturing Co., Dept. 58
570 Communipaw Ave., Jersey City, N. J.
Please send the FREE Smooth-On Handbook.

Name.....

Address.....

11-42

Do it with SMOOTH-ON

Protect your anti-freeze — clean out with Sani-Flush first

Don't waste precious anti-freeze in a dirty radiator. Rust and sediment cause dangerous overheating. Clean out first with Sani-Flush. It's quick and complete. Costs only a few cents.

Don't take chances on just flushing with water. Sani-Flush is thorough. Use it yourself, or ask your service station. *Sani-Flush is absolutely safe in auto cooling systems, when used according to directions on can.* It's in most bathrooms for cleaning toilets. Sold in grocery, drug, hardware and 10c stores. The Hygienic Products Co., Canton, O.

Sani-Flush

CLEANS OUT RADIATORS

ONAN ELECTRIC PLANTS
ALTERNATING AND DIRECT CURRENT

Produce Current, same as City Power Lines, for FARMS, SCHOOLS, THEATRES, PUBLIC BUILDINGS . . . Operate Lights, Radios, Motors, All Appliances.

Over 60 STOCK MODELS — 350 to 50,000 Watts. Any Voltage — Any Frequency. Combination A. C. - D. C. Types. Manual, Full Automatic and Self-Starting. $99 up. Shipped — COMPLETE, READY for OPERATION. THOUSANDS IN USE IN ALL PARTS OF THE WORLD. Write for Complete Details.

D. W. ONAN & SONS
1420 Royalston Avenue - MINNEAPOLIS, MINN.

The War's End

(Continued from page 229)

By the end of the war American chemists believe they will have developed synthetic rubbers of such high quality and low cost that imports of raw rubber never will be resumed on the old prewar scale. They will be ready to give you synthetic tires equal to rubber in strength and wearing qualities, and superior to it in other respects, especially resistance to corrosion by oil or gasoline.

Similarly, many experts doubt that raw silk ever will be able to win back its market from the kind of synthetic fabrics that will be available. They say American women who might prefer silk will be converted instead to the wearing qualities of sheer ny lon, while improved rayon types will dominate the lower-cost field.

The entire fabrics industry after the war will be marked by extensive blending of textile fibers. Blendings of cotton and wool with the synthetic fibers are expected to develop new types of material superior in looks, wearing quality, and ability to take dyes. Authorities say the war and its necessities have pushed the industry on through the equivalent of 10 to 15 years' normal experience in this kind of experimental blending.

Chemistry is advancing rapidly under pressure of speeded-up war research, and will make great contributions to the postwar world. Many of the major lines of research now being undertaken are so intimately involved with the war effort that even general discussion must be barred, but one important nonconfidential field is that of industrial uses for future farm-crop surpluses.

Much attention is being given to the possibility of supplementing the national supply of motor fuels with alcohols or gases derived from grain or agricultural residues. At some future time much of our motor traffic may be run on fuels from such renewable raw materials.

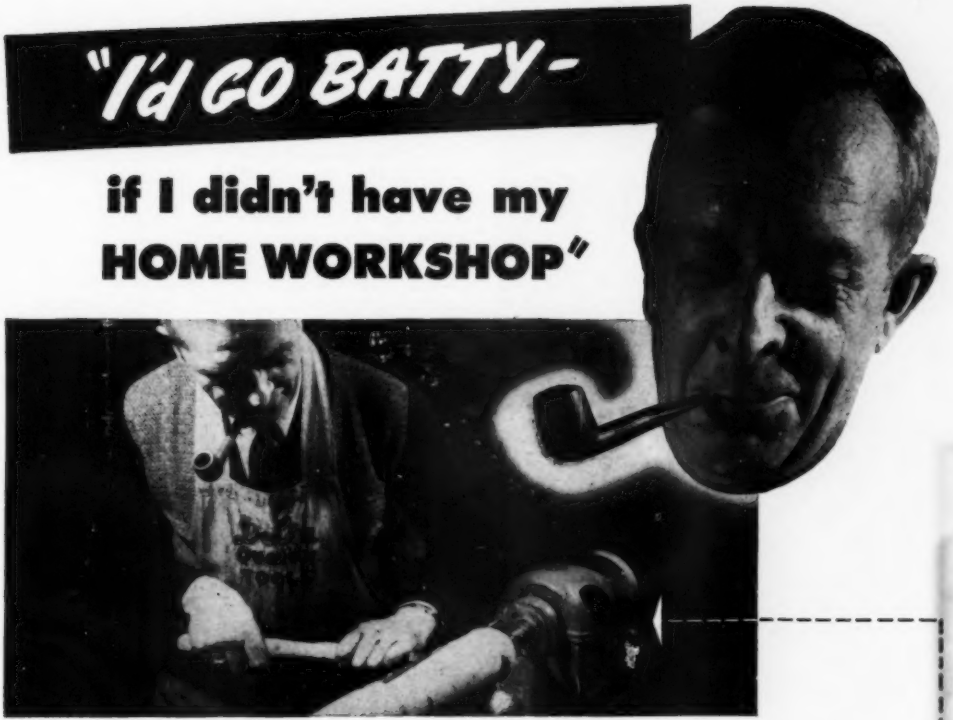
Other farm research includes the dehydration of meat and vegetables. This work was undertaken in co-operation with Army authorities and is reported to be attaining very satisfactory results.

In electricity, as in chemistry, much experimentation and practical work which will influence the world-after-the-war is now too closely connected with war work to be made public. It is known, however, that devices will be available to use high-frequency radio waves to make the navigation of ships and airplanes in dense fog

(Continued on page 232)

"I'd GO BATTY—

if I didn't have my HOME WORKSHOP"



"WHETHER you're the big boss or just one of the 'deck hands'... industrialist, professional man, military brass hat, bookkeeper or draftsman... there comes a time when you've got to get away from the strain of modern life—or go nuts!

"As for myself, I'd go batty if I didn't have my home workshop! My doctor tells me that working with my hands has a 'therapeutic value'. My friend who's a psychologist says he's been turning out gadgets in his own workshop for years because that's nature's way of obtaining 'release'."

Creating things by hand has been a normal part of human routine ever since the first Neanderthal man began chipping flint arrows. That's why thousands of industrial leaders, professional men, army officers and desk slaves are finding new happiness and relief from desk jitters by adopting a creative hobby.

Send for FREE Booklet—

"Happiness is in Your Hands." It gives full details of how happiness can be obtained through creative hand work—and contains practical suggestions for hobbies within the reach of all.

DELTA
MILWAUKEE

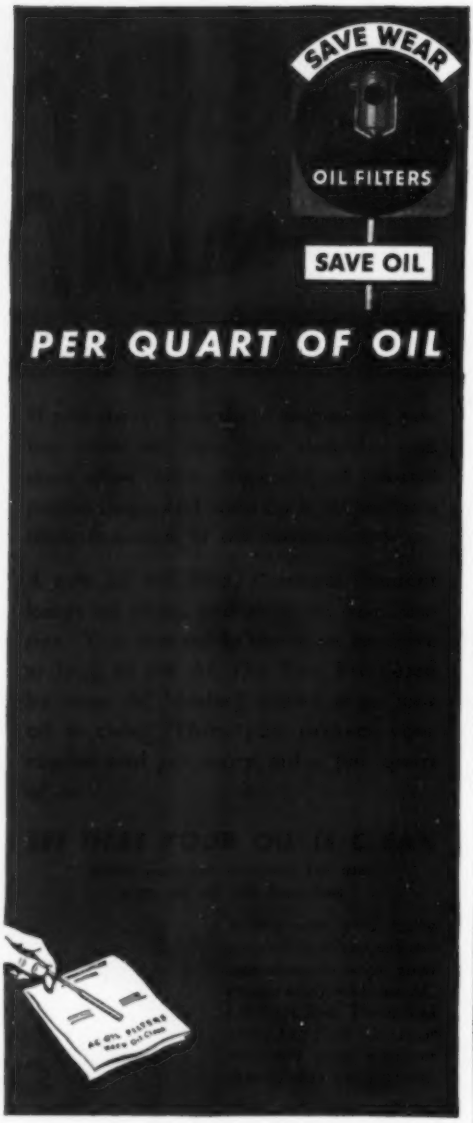
The Delta Manufacturing Company
682-M E. Vienna Ave., Milwaukee, Wis.

Please send me FREE copy of your booklet "Happiness is in Your Hands".

Name.....

Address.....

City.....*State*.....



AC OIL FILTERS

Get the Dirt

For engines not already equipped, there's a complete AC Oil Filter which your dealer can install in a short time.

LOOK FOR THIS SIGN — **There's one near you**

NOTE: *Follow the recommendation of your service man as to when oil should be changed.*

AC SPARK PLUG DIVISION · *General Motors Corporation*

The War's End

(Continued from page 230)

relatively safe. In addition, war experience has revived interest in the difficult project of laying an Atlantic telephone cable to supplement the operation of international radiotelephone circuits.

Not for the year, or perhaps the decade, after the war, but still possible in the future are various engineering projects on a stupendous scale. Most of them have teased the imagination of engineers for a generation or more past; the end of this war might make it feasible to tackle them, especially if some form of federated political unity emerges in Europe. Among these grandiose undertakings are a tunnel under the English Channel, dams at Gibraltar and the Black Sea outlet to use the Mediterranean Sea as the world's greatest hydroelectric power source, and a dam across the Congo River to provide Central Africa with a freshwater lake half the size of the Baltic Sea.

These projects may sound fantastic, but it must be remembered that we already are building a highway to Alaska, and another motor road is being driven south through Latin America. Projects like that were regarded as fantastic once, too. And when the American people set out to make a better world there are very few things they are willing to call impossible.

The Jeep's Big Brother

(Continued from page 97)

how the bowl is tipped by unorthodox antics on rough ground, the center-line height of the fuel level at the jet, centered in the concentric bowl, remains unchanged, as, accordingly, does the critical air-fuel ratio of the engine. Down inside this carburetor, too, is a built-in governor.

Above the carburetor is a new oil-bath air cleaner that extracts 99-percent-plus of the dust and dirt sucked in with the air; dust that would grind engine friction bearings like emery powder. This important gadget cut out its military future in medal-winning service on tractors working in the dusty grain fields of the Middle West. Air enters it through louvers at the back side and swirls down over a pan of agitated oil past a baffle plate, getting a scrubbing. It then flows up through a wire-mesh filter and down into the carburetor, as clean of dirt as the air after a summer shower. To clean the unit, the oil is replaced and the wire-mesh filter is doused in gasoline. You can tell at a glance when cleaning is necessary, simply

by looking at the oil level, which rises as dirt accumulates.

Like all Army vehicles built today, the three-quarter-tonner is completely radio-suppressed. This means that wherever there are sparks or intermittent currents in the ignition, generating, and current-and-voltage control parts, the circuits are equipped with resistors, suppressors, and filters; wherever metal parts are hinged or insecurely connected by electrical conductors, electrical bonds of flexible braided-metal strap connect the parts to ground; and over every high-tension wire, flexible metal shields are provided and grounded.

The purpose of this strategy is a vital one. For every truck is a potential radio transmitter, its static-generating panels and its electrical system sending out short-wave radiations. Powerful receivers tuned to the wave can detect them sometimes from several miles away. The Russians and British know all too well that the signals can attract enemy raiders to otherwise well-screened vehicle movements, and that our Army is taking them seriously, despite some pooh-poohing, is evident in the blanket suppression of this source of trouble.

On the dashboards of the three-quarter-tonners, regulation instruments include a speedometer with odometer, ammeter, oil-pressure gauge, engine-temperature indicator, fuel gauge, ignition and light switches. On the 12-volt-equipped units, a voltmeter is included. Dash lights and a hand brake complete the dash picture, but a useful part of its equipment is the luminous-painted 10 and 20-mile markers and indicator hand on the speedometer, aiding blacked-out troops to hold their given pace.

A sturdier bumper accents the stubby nose with its "high angle of approach" that lets the front wheels buck or climb obstacles for themselves. A similarly high angle of departure leaves almost no overhang at the rear to catch on shell-hole sides or strike the ground as the truck enters a sharp incline.

For this nation's bitter struggle, this rugged fighting vehicle is a powerful sermon in tactical vehicle; a sermon for which the text was taken mainly from the perfected Jeep, but also from other tactical vehicles, from swamp buggies, commercial cars, farm tractors, and the searching study of other carriers and prime movers—orthodox and unorthodox. It is a tremendous step forward toward putting our fighting men in fighting vehicles, and it was no accident that it also advanced the Army's plan for fewer chassis types and for better parts interchangeability. The Quartermasters might be proud if they had the time, but they are probably too busy working on another vehicle for our motorized Army.—SCHUYLER VAN DUYNE.

WHEN LIVES ARE AT STAKE, A GLUE HAS TO BE GOOD!

CASCAMITE meets Navy Glue Specifications for Wood Life Rafts

Uncle Sam is hard-boiled about glues for his life rafts. These resin glues must stand shear tests of 2800 lbs. per square inch on maple blocks; 340 lbs. per square inch on thin, dry plywood; 280 lbs. per square inch on thin plywood *after 48 hours water soaking!* CASCAMITE stands these tests with strength to spare, just as CASCO Powdered Casein Glue passes all casein glue specifications.

That's why you know these glues will do your homecraft and repair jobs *once and for all!* They meet Uncle Sam's toughest requirements.

CASCAMITE Powdered Resin Glue—Meets Army and Navy specifications for aircraft assembly cold press resin glue. Also specifications for life floats, truck bodies, other field equipment. Waterproof. Moldproof. Stainfree. Mixes instantly in cold water. 10c to 85c.

CASCO Powdered Casein Glue—Meets Army, Navy and Federal casein glue specifications. Highly water-resistant. Cold water mix. A "self-bonding" type glue; makes strong bonds with but moderate pressure—even on imperfectly fitted joints. 10c to 65c.

Both sold at Hardware, Paint and Lumber Dealers'. Every 25c or larger can includes coupon good for free project plan for one of 36 furniture and water sports projects.

FREE HOME AND INDUSTRIAL GLUING DATA:

CASEIN COMPANY OF AMERICA, Dept. PS1142
350 Madison Avenue, New York, N. Y.

Send me the literature checked.

☐ "Gluing Guide." Complete mixing directions for all glues. Over 80 home workshop jobs.

☐ "Project Folders." Describe free project plans.

☐ Technical Information on the industrial gluing of

_____ (fill in)

(Be sure to give your name and address clearly printed or typed.)

IF YOU'RE IN THIS FIX..

P.W. WILL FIX IT

DENTS AND NICKS can be filled in quickly and easily with PLASTIC WOOD. Can be planed and sanded, then finished like the original wood. Get it in cans or tubes at Paint, Hardware, 10¢ Stores.

HANDLES LIKE PUTTY—HARDENS LIKE WOOD

We can buy it for you

IN THAT DISTANT CITY

through Western Union Shopping Service. You describe it . . . . we will buy it and see that it is shipped to you promptly. Ask for details at any Western Union office.

IN STEP WITH UNCLE SAM

SYNCRO Electric Jig Saws enlist with Uncle Sam for the duration . . . making parts for tanks, submarines, planes, guns—producing precision machine tools, fixtures, gauges, production parts. Laboratory research guarantees BETTER Syncro Saws for you *after* Victory! See Dealer for available Syncro Saws.

SYNCRO WORLD'S SAFEST SAWS

SYNCRO DEVICES, INC.
3265 Bermuda, Dept. PS-112, Ferndale, Michigan

What Happens When You Cut Your Motor in Half!

(Continued from page 77)

starting at the front, so you eliminate either 1-3-2 or 5-6-4, but preferably the forward group. For V-8's, firing order usually is 1R-1L-4R-4L-2L-3R-3L-2R. Use either set of alternates. For 8-in-lines, the firing order is 1-6-2-5-8-3-7-4. Again use either set of alternates. On V-12 Zephyrs, either bank of cylinders is dropped. Some V-8's vary from the Ford in firing order. In any case, the rule is to cut out alternate cylinders in their firing order.

On double-tube (dual) carburetors, you simply plug the main jet and the acceleration-pump nozzle feeding the tube leading to the proper cylinders. On single-tube carburetors, you must reduce the flow of gas through the main jet by half, substituting a jet of half the orifice area, and cut the stroke of the acceleration pump by half. In effect, you have made the engine more efficient for moderate-speed driving because the throttle valve must open wider. A possible exception is on recent Buicks where the unconventional intake manifolds already give particularly good moderate-speed fuel economy.

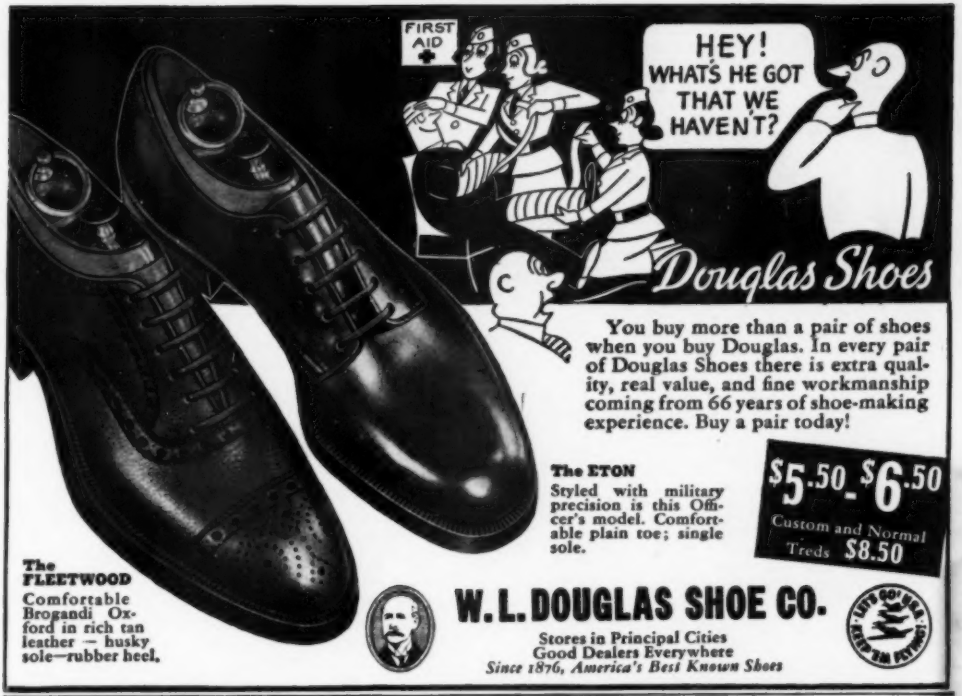
Sun Oil tests indicate that the best ignition procedure is simply to close the gap of the plugs in the killed cylinders. Do not remove the plugs' lead wires, or the high-tension coil will be damaged.

The final chore is to step up the engine idling speed to about 550 or 600 r.p.m. on sixes, 450 to 500 on eights, to make idling smoother.

Compared with the Sun Oil test on a V-8 Ford, on which a 40-percent mileage improvement was gained at 30 miles an hour, the writer's test was obviously less fruitful. Unconverted, the Sun Oil car made 24.7 miles to the gallon; converted it made 34.6. But that test was made under special conditions with a 1941 car in A-1 condition. On actual traffic tests, the Sun Company points out, at a speed of around 24 miles an hour (six less than ours), their car's mileage improvement was 24 percent, or no better than ours.

That may also be compared with a test of our altered car using a gasoline-metering gauge in New York City traffic, which showed mileage, at the necessarily restricted speeds of a busy city, ranging from a low of 14.5 miles to the gallon under worst conditions, up to a high of 25 miles under the best. For a four-year-old, down-at-the-heels car, that's good!

Please mention POPULAR SCIENCE *when writing to advertisers.*



Douglas Shoes

You buy more than a pair of shoes when you buy Douglas. In every pair of Douglas Shoes there is extra quality, real value, and fine workmanship coming from 66 years of shoe-making experience. Buy a pair today!

The ETON
Styled with military precision is this Officer's model. Comfortable plain toe; single sole.

$5.50-$6.50
Custom and Normal Treds $8.50

The FLEETWOOD
Comfortable Brogandi Oxford in rich tan leather — husky sole—rubber heel.

W. L. DOUGLAS SHOE CO.
Stores in Principal Cities
Good Dealers Everywhere
Since 1876, America's Best Known Shoes

"HOW TO WORK WITH TOOLS AND WOOD"

A popular book on woodworking, packed with illustrated instructions for beginners, and with useful data for experienced woodworkers. Every home workshop should have a copy. Send check or money order to address below.

A BIG VALUE AT $1.00

STANLEY TOOLS
DIVISION OF THE STANLEY WORKS
21111 Elm Street, NEW BRITAIN, CONN.

SOME ARMY OR NAVY MAN'S USING IT NOW!

● Some Army or Navy man's probably using the Powerlite you would like to buy today—thousands are in use in the Armed Forces. Delta's two plants are producing entirely for war. But, when the war is won there'll be Powerlites again—better if there's a way to make 'em better.

DELTA ELECTRIC CO.
Marion, Indiana

Delta POWERlite

Excellent Pay! Costs but little to learn. ACT NOW!

Offers a BETTER FUTURE!

Get training in a trade that will always need experts regardless of world or local conditions.

NO BETTER PLACE TO TRAIN than this school, backed by one of the world's largest builders of arc welders; supervised by some of America's Finest Instructor-Operators.

NON-PROFIT INSTITUTION. Cost only for materials used. Individual machines, booths. Short, intensive course. WRITE OR ENROLL TODAY!

The HOBART SCHOOL OF ARC WELDING
Box P-1121, TROY, OHIO

FREE *Literature...Write Today! Reservations are being made continually,* HURRY!

LIVE WELL IN A SCHULT!

Here's the answer to a home—quick! Schult offers the greatest possible savings in housing war workers. You can have good housing, save war materials and save money by living in a Schult. Larger, roomier, more comfortable than ever before. Private bedrooms, davenports—super insulation for maximum year round comfort. Schult construction means long life—an investment good for years. Low cost, top trade-in value and nation-wide service. See a Schult at your dealers, or write, Schult Trailers, Inc., Dept. 3111, Elkhart, Indiana.

Write FOR CATALOG

SCHULT

Schult Trailers

PHOTO ENLARGEMENTS 5¢ ANY SIZE

Is Photography your hobby? Do you want a profitable easy business at home? Make **PHOTO ENLARGEMENTS** for yourself and others. Your cost 5c each and less. The Ideal Photo Enlarger is **AUTOMATIC.** No experience required. Also **COPIES** any picture. **$7.94 COMPLETE.** Interesting circular **FREE.**

IDEAL-X, 148 West 23 St., New York

LEARN PROFITABLE PHOTOGRAPHY

Photography made easy at oldest, largest school. Qualify under full time experts for unexcelled opportunities. U.S. war program swelling demand for photographers. Resident or home study courses. Booklet FREE. **N. Y. Institute of Photography, Dept. 5, 10 West 33 St., New York, N. Y. (32nd Year)**

NEW! FREE CATALOG

RADIO·SOUND ELECTRONICS PARTS·SUPPLIES

FAST EMERGENCY SERVICE

The BIG book of BIG values! Standard radio and test equipment, thousands of parts for Radio, Electrical and Electronic assemblies. Nation wide service with Teletype connections for speed and dependability. Engineers, laboratory workers, experimenters and industrial plants look to Lafayette for everything in radio. Write for catalog PS11 today.

WRITE TODAY

Lafayette RADIO CORP.

901 W. JACKSON, CHICAGO

265 PEACHTREE ST. ATLANTA

Red Cross Offers War Bonds in National Photo Contest

BY ENTERING a national photographic competition just announced by the American Red Cross, camera enthusiasts will have an excellent opportunity to apply many of the suggestions which have appeared recently in POPULAR SCIENCE on taking defense pictures, lighting, printing, and other topics.

Awards in the contest, which begins October 1 and continues through December 31, 1942, will be War Savings Bonds with a maturity value of $5,125. The purpose of the contest, known as the American Red Cross National Photo Awards, is to provide a pictorial record of the activities of the Red Cross on the home front, at military camps, at sea, and in foreign lands. It is open to men and women in the country's armed forces and to civilians, both amateur and professional photographers, who are not employees of the American Red Cross or any of its chapters.

In calling upon photographers to enter the contest, Norman H. Davis, national chairman of the Red Cross, said: "We need the imagination of camera enthusiasts to capture the drama, the pathos, the sympathy, the mercy embodied in our work. This story must be told if the vital services entrusted to the Red Cross are to reach their greatest usefulness. We believe that pictures offer one of the most effective means of informing Americans of the great organization which has been developed through their generosity. Newsworthy photographs and those which symbolize the spirit of the Red Cross are wanted for magazine covers, feature articles, news stories, posters, and a score of other uses."

War bonds will be awarded in three monthly contests, and as grand prizes to final winners selected by a nationally known jury of photographic experts. The monthly prizes are: first prize, $200; second, $100; third, $50; and 33 honorable mentions at $25 each. The final awards are: first prize, $500; second, $300; third, $200; fourth, $100; and ten $50 honorable mentions. In addition, the Red Cross will purchase for $5 each non-winning pictures deemed worthy of use. Winners of the final awards will be announced February 1, 1943.

Folders containing complete rules for the contest are being distributed through the country's photo dealers. Headquarters of the American Red Cross National Photo Awards are at 598 Madison Avenue, New York. The director is Louis C. Boochever, of Cornell University. The contest fund was provided by the Photographic Society of America and other friends of the Red Cross.

Please mention POPULAR SCIENCE *when writing to advertisers.*

NEW WATERPROOF GLUE GETS UNCLE SAM'S O.K.*

So good it is used in Uncle Sam's planes* and ships! Yet WELDWOOD GLUE is simple as A-B-C to use! No heating, waiting or special equipment. Just add tap water to dry powder and it's *ready for instant use.* At hardware, chain stores and lumber yards in 10c, 25c, 50c cans; or send 25c with your dealer's name for sample can. *Supply limited* due to Uncle Sam's war needs.

UNITED STATES PLYWOOD CORPORATION
World's Largest Producer of Plywood
Weldwood Glue Dept.
103 Park Ave., New York

Compare These Amazing Qualities
1. Tremendous Strength
2. Waterproof
3. Rot and bacteria-proof
4. Economical
5. Stain-free
6. Quick and easy to mix

"Makes the glue line the SAFETY line"

Save your tools!

Get this FREE
DISSTON MANUAL
from your
HARDWARE DEALER

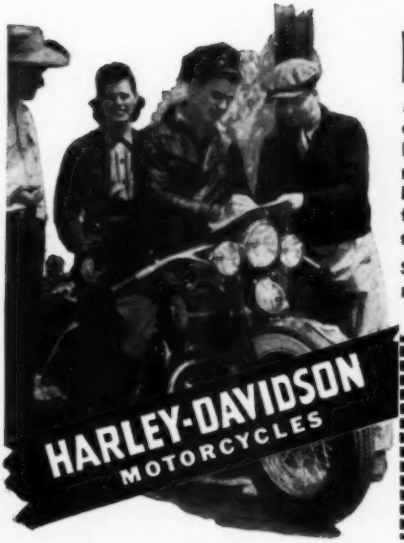
CONSERVATION • SERVES EVERYONE •

48 Pages • 200 Illustrations

Packed with useful workshop advice, instructive pictures, practical helps and hints. Contains this statement from George T. Weymouth, Bureau of Industrial Conservation, War Production Board: "TOOLS ARE WEAPONS. CONSERVE THEM. USE THEM PROPERLY TO AVOID BREAKAGE AND THE WASTE OF CRITICAL MATERIALS NEEDED TO WIN THIS WAR."... Make your tools last longer. Get your FREE copy of the Disston Saw, Tool and File Manual from your Hardware Dealer.

HENRY DISSTON & SONS, INC., 1110 Tacony, Phila., Pa., U.S.A.

ALL OUT FOR *Victory* WITH



HARLEY-DAVIDSON

Motorcycle clubs all over the country are serving in civilian defense duty. Members proudly use their rugged, dependable Harley-Davidsons for messenger and errand service, escort and patrol duty, and render valuable aid to other volunteer branches. Harley-Davidsons' greater flexibility makes them the ideal vehicles for this type of service, and their unmatched economy conserves gas, oil and rubber for the nation's Victory Drive.

See your Harley-Davidson dealer — learn about the superior performance of these world champion motorcycles. Also look over his special values in reconditioned models.

MAIL COUPON NOW

HARLEY-DAVIDSON MOTOR CO., Dept. PS, Milwaukee, Wisconsin

Send FREE copy of big 24-page "Enthusiast" magazine filled with thrilling motorcycle pictures and stories. Also literature on the latest Harley-Davidsons. Stamp is enclosed for mailing cost.

Name _____

Address _____

PAINT BRUSHES SCARCE!
Keep NEW brushes soft
RENEW old brushes

Conserve valuable Paint Brushes! *Save them* by using DIC-A-DOO PAINT BRUSH BATH after every use. Amazingly efficient in loosening, washing away paint from bristles. Brush remains good as new for long time. . . . Restores old hardened brushes to usefulness. Enough to clean several brushes. Costs only 5 cents. Get it at hardware or 5-&-10¢ stores. You'll want to keep several packages on hand. The Patent Cereals Co., Makers of Dic-A-Doo Paint Cleaner, Geneva, New York.

DIC-A-DOO Brush Bath

THOUGHTS HAVE WINGS

YOU CAN influence others with your thinking! Learn to impress others favorably—*get across your ideas.* Let the Rosicrucians show you how to use the power of mind. For *free book* write Scribe M.W.W.

The ROSICRUCIANS (AMORC)
San Jose, California

Up-to-the-minute LATHE MANUAL—Just Out

This manual will enable you to understand the modern metal-cutting lathe, its parts and their functions . . . to teach the proper care of a lathe . . . to explain the grinding of cutters; modern lathe tools and how they should be set-up; methods of holding work, and the performance of the basic lathe operations. This manual is exceptionally complete in its tool grinding charts. Only

50c

Send for LATHE CATALOG

MOTORISTS *Wanted!*

TO MAKE THIS *UNIQUE*

GAS SAVING TEST

FITS ALL CARS

Constructed of six parts fused into a single unit, adjusted and sealed at the factory. Easily and quickly installed by anyone in a few minutes.

Will you permit us to send you at our risk the Vacu-matic, a device which autoowners everywhere are praising? Install it on your car. Test it at our risk. Unless it trims dollars off your gas bills by saving up to 30% on gasoline consumption, gives more power, quicker pickup and faster acceleration, the test will cost you nothing.

Automatic Supercharge Principle

Vacu-matic is *entirely different!* It operates on the supercharge principle by automatically adding a charge of extra oxygen, drawn free from the outer air into the heart of the gas mixture. It is entirely automatic and allows the motor to "breathe" at the correct time, opening and closing as required. Saves up to 30% on gas costs, with better motor performance.

AGENTS *Get Yours FREE*

FOR INTRODUCING. Here's a splendid opportunity for unusual sales and profits. Every car, truck, tractor owner a prospect. Send name and address now for big money making offer and how you can get yours Free.
The Vacu-matic Co., 7617-75S W. State Street, Wauwatosa, Wis.

FREE RADIO CATALOG!

You'll want this Big FREE 1942 Book that shows Everything in Radio! Here's everything you need for radio servicing, for experiment, for instruction in the science of modern Radio! More than 15,000 quality radio items—replacement parts, books, tools, lab and experimental equipment—all at the lowest prices! Send for this FREE Catalog now—and don't miss the two big book values described below—They're a "must" for Everyone in Radio!

FREE *Send for It NOW*

ALLIED RADIO CORP.

Radio Builders' Handbook. Everyone in radio needs it **10¢**

Radio Dictionary. Complete, valuable, defines all terms **10¢**

833 WEST JACKSON DEPT. 7-L-2 CHICAGO

How long since you made movies of your family?
Load up your CINÉ-KODAK today

BUILD A MOSQUITO BOAT!

CARVED HULL INCLUDED! Famous Ideal 12½" Super-Detail model. Perfect building easy with our complete kit. $2.50, p.p. (Catalog 10¢)
IDEAL MODELS, 28 W. 19 St., NEW YORK

WARDS *Big Free* 1942
CAMERA AND COLOR CATALOG

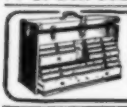
Everything you need plus 12 Hints to Better Color Photos. Bargains in Still or Movie Cameras, Projectors, Supplies. Dozens of new items . . . more than you ever thought available this year. Many items are shipped POSTPAID. At LOW PRICES CASH or TERMS. Satisfaction guaranteed or money back. Act now. Write today!

MONTGOMERY WARD
Photographic Dept. PS-1142 Chicago, Ill.

BRONZE FOUNDRY Schools and Home Workshops

Make your own castings of aluminum, copper, bronze, silver. Foundry sets are available in three sizes including 2400 Deg. F. blast Furnaces. $17.50, $34.00, $34.50, f.o.b. Kansas City. Free Circular.

KANSAS CITY SPECIALTIES CO.
P. O. Box 6022, Dep't S-34 Kansas City, Mo.



WORKMANSHIP

that is unequalled makes Gerstner Chests favorites with toolmakers and machinists. Free Catalog.
GERSTNER TOOL CHESTS
542 Columbia St. Dayton, Ohio

Print Your Own

Cards, stationery, circulars, tags, labels, advertising, etc. Save money. **Print for Others, Big Profits;** easy rules sent. Will do popular Raised Printing with any Kelsey Press. Junior outfits $8.25. Senior Outfits from $17.38. Send for free catalog and all details. KELSEY, INC., Y-33, Meriden, Conn.

METAL AND WOOD WORKING MACHINE TOOLS

Send for new FREE catalog of complete line of Machines, Motors and Accessories

WALKER-TURNER CO., INC. • 2112 Berckman St., Plainfield, N.J.

WAR VOLUNTEERS

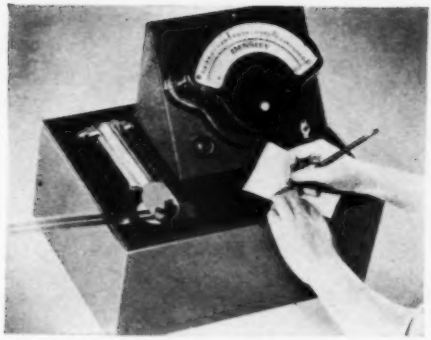
★ WITTE has been serving America for 72 years.

Materials to build famous WITTE Log Saws and Engines are now needed for war equipment. America's victory program has first call at the large WITTE factory. After victory these money-makers will again be available. They're worth waiting for.

WITTE ENGINE WORKS
Kansas City, Missouri

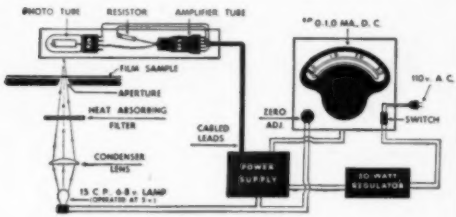
★ WITTE LOG SAWS and ENGINES ★

Please mention POPULAR SCIENCE *when writing to advertisers.*



Direct-Reading Densitometer

A NEW densitometer gives rapid direct readings of negatives in terms of photographic density. Light from a small lamp passes through the film to a photoelectric tube, where it varies the flow of an electric current in proportion to its intensity. The current is amplified and actuates a milliammeter, which is uniformly calibrated to give density readings. A high degree of accuracy is possible with a minimum of visual fatigue, even in the hands of inexperienced operators. The device plugs into any 110-volt A.C. outlet.



Mast Lights of Ship Model Have Concealed Wires

BECAUSE of the difficulty involved in drilling a hole through the length of a ship-model mast for lights, some model makers run the wires on the outside, with amateurish results. If the dowel from which the mast is to be made is first split lengthwise, either with a saw or a sharp knife, and a groove is then cut for the wires, the two portions may be glued back together and shaped as desired.—PAUL H. SMITH.

• • •

SUBSCRIBERS *are requested to notify us of change of address four weeks in advance of the next publication date. Please be sure to give both old and new address.*

STOP GOO
HESSON GUARD
MILANO $1
NO GOO CAN PASS HESSON GUARD
IT'S CUSHION SEALED
Spotless
HANDKERCHIEF TEST PROVES VITAL ZONE
NO MATTER HOW OFTEN YOU SMOKE IT
FOR PAMPHLET "S" SHOWING HANDSOME STYLES AND SHAPES WRITE: WM. DEMUTH & CO. - NEW YORK

USE YOUR BENCH SAW

With Our six in. tool steel cutters. Make mouldings, casings, drop-leaf tables, grooves beading & jointing 1" wide $1.50, 1½" $1.75. Postpaid. State size hole. List & folder free.

John A. Sandstrom, Box 517, Stow, N. Y.

MACHINISTS A Slide Rule For Only 50c.

A, B, C1, C, D & K Scales.

All American made. Multiplies, divides, solves square and cube root problems instantly. 32-page Instruction Book included free. Rush 50c today. War stamps accepted. (60c money order only from Canada.)

FRANKLIN PRODUCTS CO.

260-LB Maple Grove Ave. Fort Wayne, Ind.

OUTDOOR FUN!

Indian

SPRING FRAME

MOTORCYCLE

Exclusive "Spring Frame" smooths out roughest country roads. New comfort, safety. Brilliant streamlined beauty. See your Indian dealer.

INDIAN MOTOCYCLE CO., SPRINGFIELD, MASS.

"YANKEE" TOOLS
today . . . and tomorrow

Today, "Yankee" Tools are drilling on the production front . . . drilling holes, driving screws, tapping threads for machine screws . . . doing all those things for which they have been favored by fine mechanics for half a century. They are bringing speed and precision to the assembly lines clear across a nation that is fighting for its life. Tomorrow, when America's production has overtaken and overwhelmed the enemy, "Yankee" Tools will return to the ways of peace . . . will be seen again in dealers' windows and on dealers' counters where you may once more buy them without delay. In the meantime, Victory is their prime concern.

No. 130A "Yankee" Spiral Ratchet Screw Driver

"YANKEE" TOOLS
make good mechanics better
North Bros. Mfg. Co., Phila., U. S. A.
Established 1880

Makers, also, of "Yankee-Handyman" Tools

To safeguard and preserve the American way of life —buy Defense Savings Bonds and Stamps.
—Buy Defense Bonds and Stamps—

NO Drip —A SURE CURE

Use this plastic cork coating to stop sweating and condensation drip. Easy to apply with brush or trowel to pipes, tanks, walls, ceilings, air ducts—any surface of metal, concrete, brick, wood, plaster, etc.

Insulates and prolongs life of metal by preventing rust and corrosion. A gallon covers about 30 ft. of 1" O.D. pipe. The permanent, stucco-like finish can be painted any color. Comes in 1, 5 and 55 gal. drums.

Get at Hardware, Plumbing, Mill Supply Dealers or send $1.90 for 1 gal. prepaid. **CIRCULAR FREE.**

J. W. MORTELL CO., 534 Burch St., Kankakee, Ill.

Lens-Opening Cover Is Made of Fiber Instead of Metal

MANY photographers remove the lens from their camera for use in an enlarger, or for greater safety when carrying equipment about. During such times, however, dust and dirt may enter the camera through the lens opening, and later cause specks or scratches on negatives. A lens-opening cover effectively keeps foreign matter out, and can be inserted or removed in a moment. The new type shown above is made of fiber board covered with fabric, and sells for a lower price than the aluminum covers previously made.

Determining Exhaustion Point of an Acid Fixing Bath

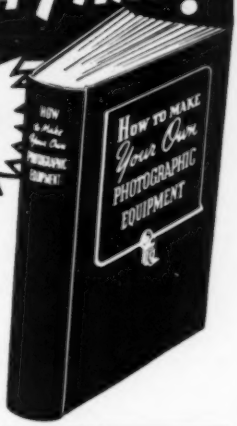
EVERY photographer realizes the value of using fresh hypo to fix his prints, but he often throws away the solution when it is still good. A quart of acid fixing bath is suitable for 2,000 sq. in. of print surface if care is taken to wash the prints thoroughly of all developer before transferring them to the bath. This means that 273 prints of the 2¼" by 3¼" size may be safely fixed before throwing out the solution. Approximate figures for other sizes follow: 2½" by 4¼", 188; 3¼" by 4¼", 144; 3¼" by 5½", 111; 4" by 5", 100; 5" by 7", 57; 8" by 10", 25.

Keep the bath on the acid side by adding a few drops of pure acetic acid occasionally. You can use blue litmus paper to test for acidity—it should turn red. Keep the temperature of the solution at about 70 deg. F., because sulphur is precipitated at higher temperatures. This causes yellow stains to appear later.—J. H. W.

381 MONEY-SAVING IDEAS FOR- CAMERA FANS!

ONLY $1.98

REGULAR PRICE $3.00



• Just think how much *fun* it would be to have your own enlarger, telephoto lens, reflectors, copying stand—and all the other equipment you need to turn out pictures that are really professional!

Now you *can* have all this apparatus! This big new book shows you how to make it yourself *—at a mere fraction of its usual cost!* Prepared by POPULAR SCIENCE'S staff of experts, "How To Make Your Own Photographic Equipment" makes every accessory so easy to build that you'll have all the equipment you ever wanted in no time at all! Hundreds of illustrations, working drawings and diagrams simplify everything!

SHOWS YOU HOW TO MAKE

An automatic print washer, "no-glass" range finder, retouching stand, darkroom ventilator, automatic timer, print dryer, developing tank, photomicrography tube, titling aids, multiple printing box, spotlights, print press—and hundreds of other accessories that will help you get more fun out of photography!

The regular price of this remarkable book is $3.00. But to introduce it quickly to a large number of POPULAR SCIENCE readers, we have temporarily reduced the price to only $1.98! *You save* 33⅓%! And just *one* of the 381 money-saving ideas in this volume can save you many times this low price!

SEND NO MONEY NOW!

Just mail the coupon below and pay the postman only $1.98, plus a few cents postage, on delivery. If, after 10 days' examination, you are not more than satisfied, simply return the book and we'll gladly refund every cent you paid! But you must act *at once* to be sure of getting your copy at this low bargain price!

MAIL COUPON TODAY!

POPULAR SCIENCE—Dept. 112
353 Fourth Avenue, New York, N. Y.

Send me HOW TO MAKE YOUR OWN PHOTOGRAPHIC EQUIPMENT. I will pay postman $1.98, plus few cents postage. If dissatisfied, I may return book within 10 days for full refund.

Name.....

Address.....

City..... State.....

(If you prefer to remit now, we pay postage. Same refund guarantee.)

LEPAGE'S IT'S NEW! WATERPROOF *plastic resin* GLUE

Here's Proof that it's absolutely waterproof!

• QUICK MIXING WITH COLD WATER

• READY-TO-USE IN 30 SECONDS

• LASTING STRENGTH

WE MADE THIS TEST

Two blocks of wood were glued together with LePage's Plastic Resin Glue. Over a year later the same two blocks were still welded tightly—proving conclusively that LePage's is *absolutely* waterproof.

Buy a can Today!

4 HANDY SIZES
10¢ 25¢ 50¢ 85¢

$2.00 a month at Age 21, Buys $1724.00 of Old Line Legal Reserve LIFE INSURANCE

$1460, at age **30; $1142,** at age **40;** etc. Premium is **$1.00 per month** per unit (minimum 2 units) or half the permanent rate for first 5 years! **All Standard Provisions,** including **Dividends,** Cash and Loan values, **Monthly income! Fully Paid up in 30 years! Postal Has No Agents. Mail Coupon Now!**

Postal Life Insurance Company
511 Fifth Avenue, Dept. D111, New York

Gentlemen: Mail me full details of new $1.00 Policy and amount of insurance at my age.

Name _____

Occupation _____ Age_____

Address _____

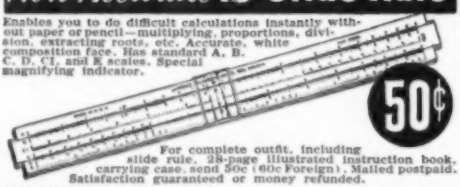
He's Your Underwood Service Representative

He will help to make your typewriters and office machines last longer and keep them at peak performance. Ask him about the Underwood Maintenance Service Plan. You'll find him listed in your telephone directory or write

UNDERWOOD ELLIOTT FISHER COMPANY
ONE PARK AVENUE • NEW YORK, N. Y.

New Accurate 10" Slide Rule

Enables you to do difficult calculations instantly without paper or pencil—multiplying, proportions, division, extracting roots, etc. Accurate, white composition face. Has standard A, B, C, D, CI, and K scales. Special magnifying indicator.



50¢

For complete outfit, including slide rule, 28-page illustrated instruction book, carrying case, send 50c (60c Foreign). Mailed postpaid. Satisfaction guaranteed or money refunded.

SPECIAL COMBINATION OFFER—Slide Rule and Instruction Book; Pocket Calculator for adding and subtracting up to 999,999; 6" Transparent Protractor and Graph Rule graduated in centimeters and inches—ALL 3 for $1.00 cash ($1.10 Foreign). Order NOW

HEWIG CO., Box 143-M, Grand Central Annex, New York City

BOYS! More boys have won fame and big awards with Gilbert Chemistry Sets than any other kind. Send for FREE 24-page book "Fun and Action for Boy Chemists." Gilbert Hall of Science, 208 Erector Square, New Haven, Conn.

WORLD'S LOWEST PRICED ADDING MACHINE Vest Pocket Size FREE TRIAL

IDEAL FOR BUSINESS OR PERSONAL USE **ONLY $2.50** TOTAL COST SEND NO MONEY

GUARANTEED ACCURATE. Not a toy. Operates with only a finger flick. Adds, subtracts, multiplies, divides. Counts up to ten million. Pays for itself over and over. Ideal Gift—for Business, Income Tax and School use. MONEY BACK GUARANTEE. Send name and address. Pay Postman only $2.50 plus postage. (Send full cash if outside U.S.) Money back in 10 days if not delighted. AGENTS WRITE.

CALCULATOR MACHINE COMPANY (Mfrs.)
DEPT. 424, P. O. BOX 1118 CHICAGO, ILLINOIS

Improper Setting May Damage a High-Grade Hand Saw

COMPLAINTS are sometimes made by amateur woodworkers that their hand saws do not cut smoothly after they have been resharpened by professional saw refitters. This may be true even if a saw-filing machine has been used and the teeth are perfectly even and very sharp. The fault lies usually in the fact that the teeth have been set too deep. With a cheap, poorly tempered saw, this defect may not matter so much, but with an expensive hard-tempered saw, damage to the teeth may result.

The depth of the set should not go lower than one half the depth of each tooth. Careful examination of the teeth of a freshly sharpened saw will show whether or not the set is the right depth and uniform throughout. A high-grade taper-ground saw requires very little set. A saw that is to be used with soft, wet woods requires more set than one used for cutting dry, hard woods.

Stains on Plaster Cleaned with Sodium Perborate

IT HAS been found that sodium perborate is fairly satisfactory for removing ring stains left on a plaster wall where rain has leaked through. A small amount is sprinkled on a cloth moistened in warm water, the cloth is rubbed over the stain, and the process is repeated if necessary until the stain becomes inconspicuous or disappears. Tooth powder in which the perborate is the active ingredient may be used for this purpose.—R. G. YOUNG, M. D.

How to Repolish Pipe Stems

SCRATCHES and tooth marks can be removed from the stem of your favorite pipe and its original luster restored by the following method: Rub down the blemishes with fine sandpaper, then use powdered pumice on a damp cloth to remove the sandpaper scratches and discolorations. Put a few drops of common automobile polish on a strip of cloth about a foot long, and polish the stem as a bootblack polishes a shoe.

Storing Woolen Bathing Suits Safely

A WOOLEN bathing suit can be kept absolutely safe from moths throughout the winter by rolling it up tightly and storing it in a 1-qt. coffee can or Mason jar with a tight-fitting lid. Be sure the suit is absolutely dry before putting it away.—R. W.

FAMOUS

Marlin

FEATURES

Deep-cut "Ballard" rifling was first introduced in 1875 by Marlin in a single shot rifle. The superiority of this new type rifling was so marked that Marlin's 1875 model soon became recognized as the world's outstanding target arm.

For many years, Marlin rifles have featured Ballard type rifling for accuracy and long life. Before shipment, all Marlin rifles have been thoroughly tested and targeted.

Marlin recently introduced a new chemical treatment for barrel bores which resists rust and corrosion. This new improvement adds to the long life and trouble-free use of Marlin rifles.

Since early in 1942, engaged solely in war production.

These famous Marlin features are worth remembering after the war is won.

1870 ★ THE MARLIN FIREARMS CO. NEW HAVEN CONN. U. S. A. ★ 1942

AC & DC GENERATORS

& power plants. 350 to 15,000 watts, self and separately excited. Available for all standard voltages, 2 & 3 wire single phase, 3 phase 4 wire. Special frequencies, 25, 30, 50 and 120. Also rotary converters, frequency changers.

Katolight, 50 Elm St., Mankato, Minn., U. S. A.

Wood workers:

Here it is! Harold Hunt's big No. 14 wood catalog! Latest **UP-TO-DATE IDEAS** for experts and amateurs; **SPECIAL BARGAINS** in rare woods, veneers, and ALL kinds of supplies. 148 pages—20 of rare woods in color. Get posted! Send only **10c** to

only 10c

CRAFTSMAN WOOD SERVICE CO.
2729 S. Mary St., Dept. B-27, Chicago, Ill.

Learn Turret Lathe Operation!

Send for the New TURRET LATHE OPERATOR'S MANUAL

Offered as the Most Authentic and Complete Text Book on Turret Lathes and Turret Lathe Operation

Every man interested in metal turning—old-timer, learner, apprentice, student—can improve his knowledge and handle tooling setups and metal turning jobs more effectively after reading this authoritative volume. Written expressly for shopmen by men who have spent the greater part of their lives in building, operating, and improving turret lathes and turning methods. Easy to read. Easy to understand. Covers all phases of metal turning. Explains methods. Suggests short cuts. Contains tables on feeds, speeds, tool angles, threads. **A de luxe edition sold far below cost by America's largest manufacturer of turret lathes.**

240 Pages! Over 350 Illustrations and Drawings

Only $1.00 Postpaid in U. S. A. Elsewhere $1.50

Mail your order

Operators' Service Bureau of THE WARNER & SWASEY COMPANY • Cleveland, Ohio, U. S. A.

I am enclosing $_____ for an Operator's Manual.

Name _____

Address _____

[D3]

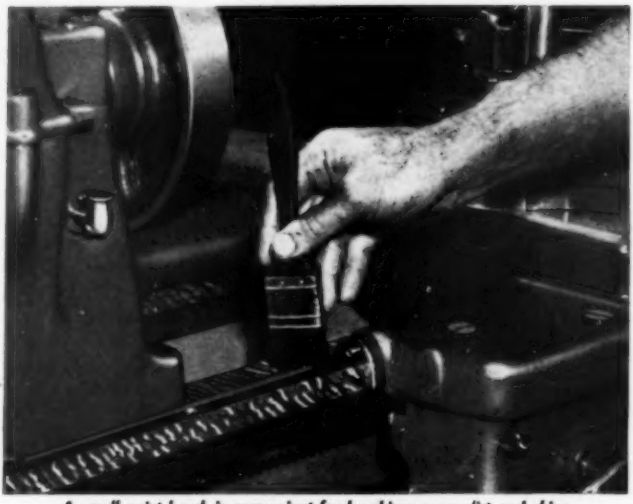
HOW TO GET THE MOST OUT OF YOUR LATHES

No. 1 in a series of suggestions made by the South Bend Lathe Works in the interest of more efficient war production.

Keep Your Lathes Clean

Yes, it's as simple as that. Just by keeping your lathes (and other machine tools) clean, you can increase production, reduce scrap, and lengthen the life of your equipment.

This will not only benefit you, but it will be a definite contribution to our total war effort. For every available machine tool must be kept going. The combined output of all machine tool builders cannot supply enough equipment to keep pace with the rapidly expanding war production program, so there can be no unnecessary replacements.



A small paint brush is convenient for brushing away dirt and chips

Dirt Is Abrasive

Unless brushed away frequently, the scale, grit and fine chips produced by the cutting tool mix with the oil on the bed ways, dovetails and other bearing surfaces, forming a dirty sludge. Because this dirt is abrasive, it increases friction and causes wear wherever it is allowed to collect.

Obviously, this retards production, shortens machine life, and makes it hard for the operator to maintain exacting tolerances. And when chips work under the tailstock or saddle, or into the spindle taper, the accuracy of the lathe may be seriously impaired.

Encourage the Operator

A good way to keep your lathes clean is to encourage each operator to take care of his own machine. Let him know that you appreciate his interest and effort. Explain how easy it is to spot a good machinist by the way he takes care of his lathe. Urge him to take pride in keeping his lathe clean, free from dirt and chips. He will have greater respect for his job and will unconsciously become a more careful workman.

A small paint brush is convenient for brushing away loose dirt and chips. Compressed air is not so good because it may blow dirt and chips into oil holes and bearings. Pliers are handy for pulling long steel shavings away from the machine. A clean cloth can be used, after brushing, to remove the last traces of dust and grit. A little oil on the cloth will prevent rust from forming on the finished surfaces of the machine.

The felt wipers on the ends of the saddle wings should be removed and cleaned in kerosene occasionally. An experienced machine tool service man should periodically inspect the lathe and remove any grit or chips that may have worked under the saddle or tailstock. The bed ways can be badly scored by a small steel chip imbedded in the saddle or tailstock base.

Don't Let Chips Collect

Adequate chip disposal should be provided to prevent chips from piling up underneath or around the lathe. Dirt and chips should not be allowed to work into the threads of the lead screw or the gearing of the apron or quick change gear box.

At a time like this, when most machine tools are operating 24 hours a day at speeds and feeds far beyond those for which they were designed, a small amount of carelessness may cause excessive wear — even a breakdown. Certainly an ounce of prevention is now worth far more than a pound of cure.

Write for Bulletin H1

Bulletin H1 giving more detailed information on the cleaning and care of the lathe will be supplied on request. Reprints of this and other advertisements in this series can also be furnished. State number of copies wanted.

SOUTH BEND LATHE WORKS

Dept. 840 • South Bend, Ind., U. S. A. • Lathe Builders for 35 Years

JUST OUT!
3rd Issue

Wor
WARPL
AND GLIDER

A Necessity for Air-Raid Wardens and Spotters; a Valuable Handbook for Ever one Interested in Aviation!

HERE'S the brand-new Third Issue of the AI SPOTTERS' GUIDE, packed with up-to-date tion on the latest planes and gliders now being used i Bigger, heavier-load American and English bombe fighters and pursuit planes, both Allied and Axis ty types of gliders, American and European! Just the tion you need to be prepared in today's emergenc are an air-raid warden, "spotter," or other civilian you will want to become thoroughly familiar with t est types of aircraft. And in any case you should knowledge as a guide to correct action in case trou

This new Third Edition of THE AIRCRAFT new from cover to cover. It is edited by Harold E Lieut. Colonel (inactive) Army of the U. S., form of Training, U. S. Air Corps. It includes the latest Army and Navy information.

Shows All Recognizable Characteristics

This valuable 100-page book describes and illustrates 20 new type British war planes, 17 German planes, 7 Japanese planes, 23 American planes, 7 Italian planes, 4 French planes, and 12 Russian planes. Not only are you shown exact, authoritative photographs of all these aircraft, but you are given specifications, markings, and other information to assist you in positive identification either when viewed in the air or on the ground. Silhouette views show each plane from three different angles. A quick-reference index is included.

THE AIRCRAFT SPOTTERS' GUIDE is in a convenient handbook size, measuring 5¾ by 9 inches, with rounded corners. It can easily be carried in coat pocket or supply bag. It also belongs on the desk of every warden post, every civilian training headquarters, every school warden, and wherever alertness is the watchword. Rush your order for a copy today.

THIS book thoritati guide for ested in av hobby or a full-time c like to buil haps you to the com the airplan chanic, flye Perhaps yo in aircraft to qualify f this Guide many help up-to-date tion.

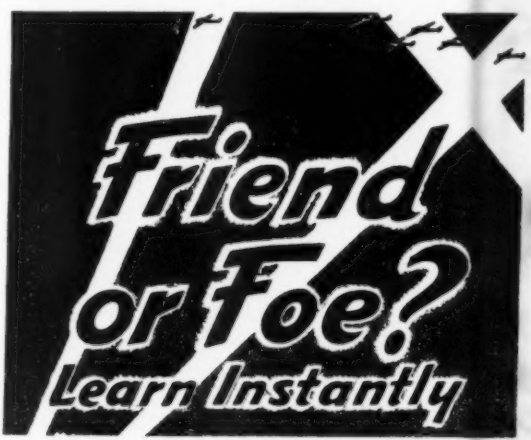
Copyright 1942 by National Aeronautics Council, Inc.

Know the World's Newest
WARPLANES AND GLIDERS

JUST published—the new Third Issue of THE AIRCRAFT SPOTTERS' GUIDE—with 100 pages of up-to-date pictures and facts on the world's newest warplanes and gliders.

This new Guide (more fully described on the inside of this cover) has just been published especially for today's emergency, which calls upon every citizen to be well-informed as a measure of preparedness. Every important new Allied and Axis plane is fully pictured and described. Every well-known German, Japanese, and Italian plane is illustrated from many different angles. Every new type of American and British plane is pictured. French and Russian planes are included.

This New Third Issue of THE AIRCRAFT SPOTTERS' GUIDE will not only be an indispensable handbook for everyone charged with civilian defense duty, but will provide a wealth of useful information and ideas for anyone interested in aviation as a hobby or as a career. *The amazingly low price of 25 cents* makes it possible for all to own a copy. Get yours immediately.



SUPPOSE you were an air raid warden, "spotter," or just Mr. John Citizen, and saw a group of planes in the sky, would you know when to give the alarm—how to distinguish between our own or enemy planes? Do you know that the silhouettes of these planes identify them at great distances just as positively as though they were on the ground? Now you can have at your finger-tips not only the silhouettes, but actual photographs, specifications and markings of 90 of the world's most up-to-date fighting planes—in this new Aircraft Spotters' Guide.

Only 25c

SEE INSIDE OF THIS COVER FOR DETAILS & SPECIAL ORDER FORM

HOW TO GET OUT OF YOU

No. 1 *in a series of suggestions ma*
Lathe Works in the interest of more e

Keep Your Lathes Clean

Yes, it's as simple as that. Just by keeping your lathes (and other machine tools) clean, you can increase production, reduce scrap, and lengthen the life of your equipment.

This will not only benefit you, but it will be a definite contribution to our total war effort. For every available machine tool must be kept going. The combined output of all machine tool builders cannot supply enough equipment to keep pace with the rapidly expanding war production program, so there can be no unnecessary replacements.

Dirt Is Abrasive

Unless brushed away frequently, the scale, grit and fine chips produced by the cutting tool mix with the oil on the bed ways, dovetails and other bearing surfaces, forming a dirty sludge. Because this dirt is abrasive, it increases friction and causes wear wherever it is allowed to collect.

Obviously, this retards production, shortens machine life, and makes it hard for the operator to maintain exacting tolerances. And when chips work under the tailstock or saddle, or into the spindle taper, the accuracy of the lathe may be seriously impaired.

Encourage the Operator

A good way to keep your lathes clean is to encourage each operator to take care of his own machine. Let him know that you appreciate his interest and effort. Explain how easy it is to spot a good machinist by the way he takes care of his lathe. Urge him to take pride in keeping his lathe clean, free from dirt and chips. He will have greater respect for his job and will unconsciously become a more careful workman.

A small paint brush is convenient

A small paint brush

for brushing away loose chips. Compressed air is because it may blow dirt into oil holes and bearings handy for pulling long st away from the machine. can be used, after brush move the last traces of d A little oil on the cloth rust from forming on surfaces of the machine.

The felt wipers on the saddle wings should be cleaned in kerosene occa experienced machine tool should periodically inspe and remove any grit or may have worked under tailstock. The bed ways ly scored by a small st bedded in the saddle or ta

Don't Let Chips Collec

Adequate chip disposa

JUST OUT! 3rd Issue

World

WARPL

AND GLIDERS

A Necessity for Air-Raid Wardens and Spotters; a Valuable Handbook for Everyone Interested in Aviation!

HERE'S the brand-new Third Issue of the AIRCR SPOTTERS' GUIDE, packed with up-to-date info tion on the latest planes and gliders now being used in the Bigger, heavier-load American and English bombers! I fighters and pursuit planes, both Allied and Axis types! types of gliders, American and European! Just the info tion you need to be prepared in today's emergency. I are an air-raid warden, "spotter," or other civilian volu you will want to become thoroughly familiar with these est types of aircraft. And in any case you should have knowledge as a guide to correct action in case trouble c

This new Third Edition of THE AIRCRAFT GUID new from cover to cover. It is edited by Harold E. Har Lieut. Colonel (inactive) Army of the U. S., formerly of Training, U. S. Air Corps. It includes the latest avai Army and Navy information.

Shows All Recognizable Characteristics

This valuable 100-page book describes and illustrates 20 new type British war planes, 17 German planes, 7 Japanese planes, 23 American planes, 7 Italian planes, 4 French planes, and 12 Russian planes. Not only are you shown exact, authoritative photographs of all these aircraft, but you are given specifications, markings, and other information to assist you in positive identification either when viewed in the air or on the ground. Silhouette views show each plane from three different angles. A quick-reference index is included.

THE AIRCRAFT SPOTTERS' GUIDE is in a convenient handbook size, measuring 5¾ by 9 inches, with rounded corners. It can easily be carried in coat pocket or supply bag. It also belongs on the desk of every warden post, every civilian training headquarters, every school warden, and wherever alertness is the watchword. Rush your order for a copy today.

THIS book will thoritative, guide for every ested in aviation, hobby or a study, full-time career. like to build mode haps you are loo to the coming op the airplane indu chanic, flyer, mai Perhaps you are in aircraft produc to qualify for milit this Guide will pro many helpful ide up-to-date and us tion.

Copyright 1942 by National Aeronautics Council, Inc.

SOUTH BEND

Dept. 840 • South Bend, Ind., U. S

d's Newest
ANES
S

BRAND NEW 100 PAGE QUICK-REFERENCE GUIDE

with Photographs, Specifications and Three Silhouettes of Each Plane in Flight! Latest Types, U. S., Great Britain, Russian, Jap, German, etc.!

only 25¢

RAFT
orma-
e war.
Faster
New
orma-
If you
nteer,
new-
e this
comes.
DE is
rtney,
Chief
ilable

be an au-
up-to-date
yone inter-
, whether as a
y, as a part or
Perhaps you
el planes. Per-
ooking forward
pportunities in
ustry, as a me-
intenance man.
now employed
action, or want
itary aviation—
rovide you with
eas and much
useful informa-

RUSH ORDER-FORM & LABEL AT RIGHT

Cut out **ORDER FORM** and **SHIPPING-LABEL** at the right. Fill in carefully (preferably print) your name and address **ON EACH.** On the **ORDER FORM** you will see a Handy Coin Holder. Simply slit open the perforated lines in the center of the circle and slip a quarter under the band thus formed. Then on the **SHIPPING LABEL** affix a 3 cent stamp in the space provided. Fold as directed, place forms in envelope and mail at once! National Aeronautics Council, Inc., 37 West 47th Street, New York, N. Y.

CUT HERE

SHIPPING LABEL

A 3-Cent Stamp Must Be Affixed Here By You. Print Name and Address in Block Letters

from National Aeronautics Council, Inc.
37 West 47th Street, New York, N. Y.

Name _____

Address _____

City & State _____

Aircraft Spotters' Guide—No. 3

FOLD HERE

ORDER FORM

National Aeronautics Council, Inc.,
Dept. 8011, 37 West 47th St., New York, N. Y.

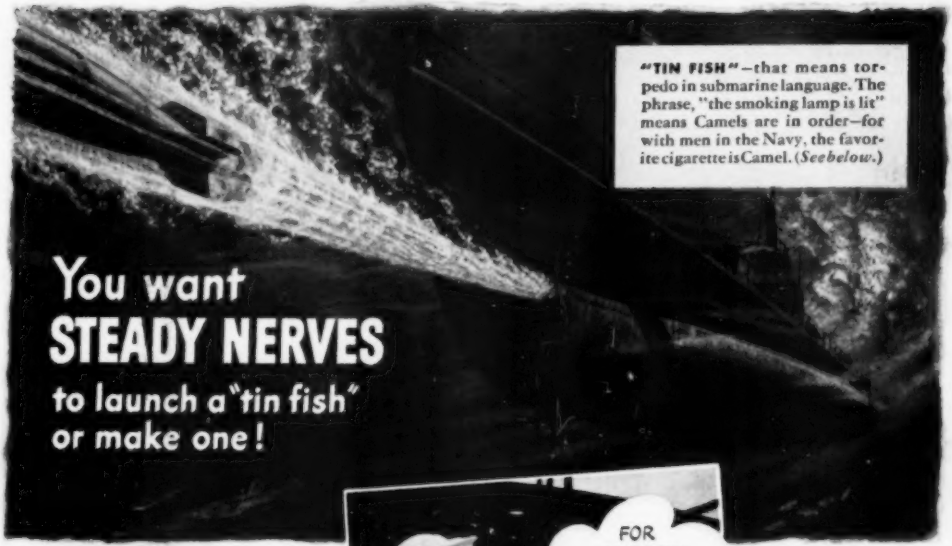
Please rush a copy of THE AIRCRAFT SPOTTERS' GUIDE, 3rd Issue, by Lieut. Colonel Harold E. Hartney. I have enclosed a 25c piece in the Coin Holder at the right, and affixed a 3c stamp to the Shipping Label attached.

Put a quarter under this band

Name _____

Address _____

City & State _____



"TIN FISH"—that means torpedo in submarine language. The phrase, "the smoking lamp is lit" means Camels are in order—for with men in the Navy, the favorite cigarette is Camel. *(See below.)*

You want STEADY NERVES to launch a "tin fish" or make one!

HIDE-AND-SEEK. A deadly game of it with the T.N.T. of depth charge and torpedo—a game only for steady nerves!

But, then, what isn't in these days—with all of us fighting, working, living at the highest tempo in years. Yes, and smoking, too—perhaps even more than you used to.

For the sake of your own smoking enjoyment, try Camels. Put them to the "T-Zone" test described below and make your own comparisons.

FIRST IN THE SERVICE

In the Navy—in the Army—in the Marine Corps—in the Coast Guard—the favorite cigarette is Camel. (Based on actual sales records in Ship's Service Stores, Ship's Stores, Sales Commissaries, Post Exchanges, and Canteens.)

THE CIGARETTE OF COSTLIER TOBACCOS

R. J. Reynolds Tobacco Co., Winston-Salem, N. C.

The "T Zone" where cigarettes are judged

The "T-ZONE"—Taste and Throat—is the proving ground for cigarettes. Only your taste and throat can decide which cigarette tastes best to you . . . and how it affects your throat. For your taste and throat are absolutely individual to you. Based on the experience of millions of smokers, we believe Camels will suit your "T-ZONE" to a "T." Prove it for yourself!

GYROSCOPE GIRL—Rosemary Gregory *(above)* calibrates automatic directional devices at a Sperry Gyroscope Co. plant, and she's just as partial to Camels as the fighting men who depend on her precision. She says: "Camels suit me better all ways—for taste and my throat."

Camel